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OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART VI.

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CONTENTS.

PAGE

I. Report upon the Bacteriological and Experimental Investigations during the Summer of 1906. By J. W. H. EYRE, M.D., F.R.S. Edin., Bacteriologist to Guy's Hospital and Lecturer on Bacteriology in the Guy's Medical School; Major J. G. McNAUGHT, M.D., R.A.M.C.; Captain J. C. KENNEDY, M.B., R.A.M.C.; and T. ZAMMIT, M.D., Government Analyst, Malta, and Professor of Chemistry, Malta University 3

I. REPORT UPON THE BACTERIOLOGICAL AND EXPERIMENTAL INVESTIGATIONS DURING THE SUMMER OF 1906.

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SYNOPSIS OF CONTENTS.

PAGE

Preliminary Notes on Methods 4

I.—The Goat as a Factor in the Dissemination of Malta Fever.

1. The distribution of milch goats naturally infected with *Micrococcus melitensis* 7
2. The agglutination test as applied to the milch goat 14
3. The numerical relationship of *M. melitensis* to the milk of infected goats 19
4. The presence of *M. melitensis* in milk products 25
5. The susceptibility of the goat to, and path of infection by, *M. melitensis* 28
6. The localisation of *M. melitensis* in the infected goat 36
7. The transmission of *M. melitensis* antibodies to the descendants of infected goats 41
8. The treatment of infected milch goats with *M. melitensis* vaccine 42

II.—*M. melitensis* Infection by Experimental Feeding with Infected Goats' Milk.

1. General considerations 44
2. Feeding experiments with naturally infected milk artificially reinforced 48
3. Feeding experiments with naturally infected milk alone 57
4. Clinical features of food infection (*M. melitensis*) in the monkey.. 65
5. The action of hydrochloric acid and of artificial gastric juice on *M. melitensis* 68

III.—*M. melitensis* infection following the ingestion of infective milk in man 70

Résumé of the outbreak of Mediterranean Fever on board the ss. "Joshua Nicholson."

1. History of the goats 70
2. Incidence of Mediterranean Fever among those who partook of the milk 71
3. The results 72

PAGE

IV.—The *Rôle* of the Mosquito and other Blood-sucking Insects in the Dissemination of *M. melitensis*.
1. Species of mosquitoes occurring in Malta 73
2. Supply of mosquitoes, and notes on their habits in captivity 77
3. Duration of life of *M. melitensis* in the body of the mosquito ... 80
4. Experiments with *Acartomyia Zammitii* 82
Duration of life of *M. melitensis* in Acartomyia 83
Virulence of *M. melitensis* after passage through Acartomyia 85
Acartomyia as the infective agent 85
5. Experiments with *Stegomyia fasciata* 91
Duration of life of *M. melitensis* in Stegomyia 91
Stegomyia as the infective agent 92
6. Experiments with other species of mosquitoes 94
7. Biting flies, *Stomoxys calcitrans* 96
Duration of life of *M. melitensis* in Stomoxys 96
Stomoxys as the infective agent 97
8. Fleas and bugs 99

V.—Naturally acquired infection (*M. melitensis*) in various animals 101

VI.—*M. melitensis* infection by means of Personal Contact 107

VII.—Prophylactic Vaccination with *M. melitensis* Vaccine.
1. The subjects selected for vaccination and the results 115
2. The vaccine 116
3. The inoculations 119
4. Clinical phenomena 120
5. Tabular details 121

VIII.—Clinical Observations on Malta Fever 123

IX.—Conclusions and Recommendations 130

Preliminary Notes on Methods.

A brief summary of the technique employed for the isolation and identification of *M. melitensis*, the performance of the agglutination test, and the selection of experimental animals, is inserted here in order to avoid unnecessary repetition in the body of the Report.

Isolation of M. melitensis.

1. *Medium.*—Nutrient peptone broth, prepared from Brand's Essence of Beef and standardised to +10 (Eyre's scale), was frequently used for the preliminary enrichment of blood, etc., but the medium generally employed for the isolation of *M. melitensis*, and except where otherwise stated, was a nutrose-litmus-agar prepared on a basis of peptone broth, containing nutrose to the extent of about 1 per cent., tinted with litmus solution to an arbitrarily chosen colour standard, and standardised so far as concerns reaction to +10 (Eyre's scale).

This was the medium employed by the members of the Commission during the years 1904 and 1905; and although by no means the optimum medium, it was decided to continue its use throughout 1906 in order to render the results absolutely comparable with those of former workers.

2. *Method of Culture.*—This medium was used in the form of surface "plates"—the liquefied agar being poured into Petri dishes, allowed to "set," and, as a preliminary to inoculation, incubated for 24 hours at 37° C., so that any accidentally contaminated plates might be detected and discarded. In preparing plates, the infected material was deposited near the centre of the surface of the nutrose-agar and then distributed over the entire surface of the medium by the aid of a sterile L-shaped glass spreader. In the case of grossly-contaminated material, several plates were prepared *in series*—that is to say, after the first plate had been inseminated the same spreader was employed to inoculate a second, then a third, and even a fourth and fifth with the traces of infective material still adhering to it—a method which yields dilutions comparable to those prepared by measuring with loopfuls when the liquefied medium in tubes is inoculated and then used for pouring plates.

Incubation was invariably carried out aerobically at 37° C., and in those cases where colonies of *M. melitensis* had not developed by the second or third day, all plates were studied for at least seven days—except where the plates were so grossly contaminated as to be unworkable.

Identification of M. melitensis.

Suspicious colonies of cocci developing on these plates were first tested with serum derived either from patients suffering from Malta Fever or from experimental animals, in dilution of, usually, 1 in 100. Such as responded to this test and yielded a positive agglutination reaction were sub-cultivated in tubes of ordinary agar (+10), and the subsequent growths, before being recorded as due to *M. melitensis*, were required to conform to the following criteria:—

1. Size, shape, and Brownian activity
2. Readiness and homogeneity of emulsion

} Corresponding to those exhibited by authentic type cultures.

3. Non-retention of stain when treated by Gram's method.
4. Production of alkaline reaction without change of consistency in litmus milk.
5. Complete clumping when tested with specific agglutinating serum in high dilution: the dilution varied with the maximum titre of the serum employed, but was usually 1 in 1000.

In many cases the cocci under examination were further tested as to their ability to produce *M. melitensis septicæmia* in the guinea-pig when inoculated intracerebrally.

Performance of Agglutination Reactions.

The culture employed was invariably an early sub-culture grown on ordinary +10 agar in "sloped" tubes and usually for 24 or 48 hours

at 37° C., from a strain of *M. melitensis* that had recently been isolated from the animal body. Occasionally, but very rarely, it was found necessary to use three-day-old cultures, but the use of such old cultures was discouraged as much as possible.

The growth was emulsified in sterile 0·1 per cent. salt solution or in sterile distilled water, in the proportion approximately of 0·5 milligramme of bacterial growth to 1 c.c. of fluid.

The serum to be tested was diluted with normal saline solution and deposited in a series of small test-tubes. The dilutions prepared started with 1 in 5 (20 per cent.), and 1 in 10 (10 per cent.), and proceeded upwards in tenths of the first named—*e.g.*, 1 in 50 (2 per cent.), 1 in 500 (0·2 per cent.), and so on, so that when equal quantities of emulsion and diluted serum were mixed, dilutions of 1 in 10, 1 in 20, 1 in 100, 1 in 1000, etc., were available for examination, other secondary dilutions, 1 in 50, 1 in 200, etc., being prepared and examined as occasion required.

The examination was carried out both microscopically in the hanging drop, and macroscopically in sealed Pasteur pipettes—each method of observation being carefully controlled by a blank preparation consisting of equal quantities of normal salt solution and emulsion of *M. melitensis*.

In the microscopical examination, the period of observation was limited to 30 minutes, and the result recorded as positive (+) when *all* the cocci were agglutinated into large clumps and none remained free in the fluid; as incomplete (±) when the clumps were small, and many cocci, singly and in pairs, were scattered about the field; and as negative (−) when clumps were very small, comprising only a dozen or so individual cocci, or were completely absent.

In the macroscopical examination, the period of observation was extended, if necessary, to 24 hours, and a positive result recorded only when the supernatant fluid was quite clear and all the cocci had sedimented into a compact mass at the point of the pipette; a loose mass of cocci below and slightly turbid fluid above was returned as an incomplete reaction, and where the contents of the pipette closely resembled those of the control a negative reaction was recorded. In only a very few of the many thousands of preparations put up during the course of the summer did the macroscopical and microscopical results fail to control and confirm each other.

Selection of Animals for Experimental Work.

Healthy animals, such as goats, kids, and monkeys, after purchase, were placed in the Lazzaretto as soon as they reached the Commission. Here they were tethered—out of reach of each other in the various stables and rooms which had been rendered fly- and mosquito-proof by

covering the windows with fine gauze and supplying the doorways with mosquito-netting curtains—away from either infected animals or healthy animals already stabled there. The rectal temperature was taken night and morning; the blood repeatedly examined for the presence of specific agglutinins, and, in the case of milch goats, the milk examined for the presence of the *M. melitensis.* Only when the temperature showed an absence of marked excursions from the accepted normal, and no evidence of infection with *M. melitensis* could be detected, were the animals regarded as "healthy and normal," and as such used for the experimental work of the Commission.

I.—The Goat as a Factor in the Dissemination of Mediterranean Fever.

1. *The Distribution of Milch Goats Naturally Infected with* M. melitensis.

The work of the previous year in collecting information respecting the distribution of infected goats by examining herds from various parts of the island was continued as opportunity afforded in 1906. In the first place, the milk supply of various military centres and the village of Lia were investigated with the following results:—

Table I.—The Proportion of Healthy and Infected Milch Goats in various Herds.

Herd supplying.	No. of goats in herd.	Milk reaction in	*M. melitensis* in milk of
1st Rifle Brigade	46	7	1
West Kent Regiment	40	10	3
(Re-examination of reacting goats)...		(3)	(0)
Citta Vecchia Sanatorium*	38	12	3
Forrest Hospital†	8	0	0
Imtarfa Hospital	60	2	0
Valletta Hospital‡	18	6	1
Lia	85	8	0
Total	295	45	8
Percentage	...	15·2	2·7
* The corresponding figures for 1905 were	15	11	5
† " " "	15	5	1
‡ " " "	13	4	1

The small number of goats (18 animals) examined in connection with Valletta Hospital comprised only about one-quarter of the

goats actually supplying milk to the hospital, but the passive resistance of the goatherds in relation to the collection of samples, which was in no way overcome by the loud protestations of the contractor, resulted in the absence of the remainder of the goats whenever an attempt was made to collect specimens of milk. Within a few days of the examination of this small portion of the herd a general strike of the goatherds supplying milk to Valletta was instituted and maintained from May 14th until June 1st, 1906. The strike lasted, in fact, until all the military hospitals and the majority of other large consumers had been compelled to replace their supplies of goats' milk by various brands of condensed or other tinned milk. Having thus forfeited their contracts and being no longer in the position of supplying milk to the hospitals and regiments, all hold over the goatherds was lost, and it was subsequently found to be impossible to complete these examinations in which a portion only of a herd had been investigated.

A comparison with the results obtained in 1905* shows that the average number of infected animals, per herd, was much smaller than that noted when large numbers distributed over more extensive areas were dealt with, and forcibly illustrates the fallacy which would attend generalisations from the results obtained above.

At the commencement of the season's work when comparing the incidence of Malta Fever upon the civil population of the island in the various local centres, the severity of this incidence upon certain villages, and the apparent absence of the disease from others closely adjacent, was particularly noticeable, and it was decided to carefully investigate the milk supply of Rabato, a suburb of Citta Vecchia, and to remove from time to time such goats as were found to be discharging *M. melitensis* in their milk from the herds examined, and study the effects of the removal of so much infective material from a restricted area upon the incidence of the fever.

This plan was at once put into execution, and a preliminary examination of the Rabato herds gave the following results :—

Table II.—Infected Goats at Rabato.

No. of herds examined.	No. of goats examined.	No. of milks reacting.	No. of milks containing *M. melitensis*.
49	342	52	16
	Percentage......	15	4·6

* *Vide* Zammit, these Reports, IV, 96 *et seq.*; Horrocks and Kennedy, IV, p. 37 *et seq.*

At first all went well. Samples were readily supplied, and the 16 infected goats were handed over by their owners for observation and treatment at the Lazzaretto, where each was supplied with a collar bearing a metal disc on which was stamped a serial number, to aid in the ready identification of the individual goats. The serial numbers commenced at 101 in order to avoid any confusion with experimental and other goats remaining at the Lazzaretto from previous years. (These animals were subsequently purchased at valuation and were utilised for experimental observations throughout the summer.) Soon, however, the influence of the goatherds' strike in Valletta spread to the provincial districts, and the goatherds of those villages in which operations were being carried on, refused in their turn to allow milk samples to be taken.

Unfortunately, the local ordinances and statutes regulating the supply of food stuffs take little active cognisance of the goat as a source of milk, and proved totally inadequate—at any rate from a diplomatic standpoint—to enforce compliance with the requests of members of the Working Party even when supported by sanitary inspectors, and the observations had perforce to be abandoned. The details of the examinations that were carried out are, however, inserted in Table III, because from them, incomplete though they are, emerge one or two suggestive points of more than passing interest.

A subsidiary matter was to have been the investigation of those milch goats which, by the presence of specific agglutinins in their body fluids, gave evidence of infection, recent or remote, by *M. melitensis*, but whose milk did not contain the micro-organism. It was hoped that by a careful study of these animals some criteria might be arrived at by which it would be possible to determine whether the infection was so remote that the milk would remain innocuous, or so recent that the appearance of *M. melitensis* in the milk would be an ever-present danger.

This investigation likewise had to be temporarily abandoned with the larger experiment.

During the course of the investigations, perhaps the most striking observation recorded was the healthy appearance of the majority of the infected goats. The animals were sleek and plump, with smooth, healthy-looking coats; they took their food well, were as active as their uninfected fellows, and yielded as large a quantity of milk and of apparently as good a quality. Palpation failed to reveal any enlargement of lymphatic glands or of alteration of the mammary gland. In many instances the infected milch goats were the best looking and the best milkers in the herd, and in a few instances only it was noted that an infected animal suffered from a short barking cough at infrequent intervals.

Perhaps the most noteworthy feature in the following table is the

*Table III.—Examination of Herds at Rabato.

No. of herd.	Name of owner.	No. of goats in herd.	No. of milks reacting.	No. of milks containing *M. melitensis*.	Cases of Malta Fever on the premises during the current 12 months.
1	F. Vassallo	2	0	—	—
2	M. Borg	2	0	—	—
3	P. Cutajar	15	0	—	—
4	G. Mifsud	3	0	—	—
5	G. Agius	24	9	4	1
6	A. Micallef	4	0	—	—
7	G. Vassallo	5	0	—	—
8	P. D'Anatas	3	0	—	—
9	G. Ciantar	4	0	—	—
10	G. Attard	2	0	—	—
11	S. Micallef	7	2	1	1
12	L. Micallef	4	0	—	—
13	G. Galea	6	2	1	1
14	G. Azzopardi	5	3	2	2
15	L. Sant	11	4	—	1
16	G. Attard	8	2	—	1
17	F. Micallef	5	0	—	—
18	P. Sant	22	6	—	1
19	G. Grech	9	0	—	—
20	G. Inguanez	5	0	—	—
21	G. Micallef	8	0	—	—
22	P. Micallef	2	0	—	—
23	F. Galea	14	1	—	—
24	G. M Azzopardi	7	1	—	—
25	S. Pace	12	0	—	—
26	C. Formosa	13	0	—	—
27	G. Micallef	4	1	—	1
28	V. Azzopardi	7	1	—	1
29	G. Vassallo	2	0	—	—
30	P. Borg. A	4	1	—	—
31	C. Borg	2	0	—	—
32	G. Micallef	1	0	—	—
33	G. Azzopardi	12	0	—	—
34	A. Dimech	5	0	—	—
35	F. Micallef	4	0	—	—
36	P. Borg	1	0	—	—
37	A. Dimech	1	0	—	—
38	V. Borg	17	10	7	2
39	C. Borg	29	2	—	—
40	Carmela Mifsud	9	4	1	*
41	G. Zahra	14	4	1	5
42	F. Vassallo	5	0	—	—
43	F. Portelli	2	0	—	—
44	S. Camilleri	2	0	—	—
45	C. Calleja	3	0	—	—
46	V. Attard	5	0	—	—
47	P. Formosa	9	1	—	1
48	C. Mifsud	4	0	—	—
49	S. Dingli	2	0	—	—

* In close association with next-door neighbour and relative (G. Zahra), owner of Herd No. 41, in whose house five cases have occurred.

occurrence of one or more cases of Malta Fever during the present twelvemonth in the household of every owner of a milch goat, which, by reason of the isolation of the *M. melitensis* from its milk, was conclusively proved to be infected, with one exception, viz., in the case of Herd No. 40, whose owner occupied the adjoining house to the owner of Herd No. 41. Here the two families and the two herds were intimately acquainted and in close daily contact, and in the house of the owner of Herd No. 41 no less than five cases of Malta Fever have occurred.

This association of cases of Malta Fever in man with infected milch goats suggests in a striking manner the highly infective character of the milk cultivation—usually practically pure—of *M. melitensis* yielded by many of these milch goats, for the Maltese goatherd keeps his goats for profit and rarely uses goat's milk as a food for himself or his family; and we are, personally, convinced from our enquiries and observations that, in the vast majority of cases occurring in goatherds and their families, infection is contracted during the handling of this food by the direct inoculation of infected milk into cuts, scratches and abrasions on the face, hands, forearms, feet and legs of the individual.

Cases were also present in some of the households where the herds contained milch goats, which, although yielding a positive agglutination reaction at the time of examination, were not passing the micro-organism in the milk. This, however, is no matter for surprise, and in no way militates against the views expressed above, for, as it will be mentioned later, it is not uncommon for a milch goat to yield milk one day containing more than 30,000 *M. melitensis* per cubic centimetre, and a few days later, milk apparently quite free from the microbe.

It has already been stated that many of these herds at Rabato were examined more than once, some a second time three weeks after the preliminary examination, and a few on a third occasion a fortnight later, before the milk vendors' strike became general. These re-examinations and their results are set out in Tables IV and V.

Inspection of these tables shows also the variation in size that individual herds undergo during comparatively short periods, in the present instances quite apart from the diminution in numbers resulting from the removal of those goats whose milk yielded *M. melitensis* from their respective herds to the experimental stables at the Lazzaretto.

The figures quoted were obtained by actual observation and by comparison with the Registration Books kept at the local police headquarters; for a system is in vogue under which every goat owner reports, personally or by proxy, the number of goats in his possession every Saturday to the police. The number thus reported includes kids, male goats, and pregnant females not yielding milk as well as milch goats in full milk, the object of registration being to assist the Sanitary Service in the event of the occurrence of an epidemic of foot-and-mouth disease, by calling attention to any diminution in the number of

Table IV.—Re-Examination of certain Herds at Rabato.

No. of herd.	No. of examination.	No. of goats in herd.	No. of milks reacting.	No. of milks containing *M. melitensis*.
3	First	15	0	0
	Second	10	0	0
4	First	3	0	0
	Second	3	0	0
5	First	24	9	4
	Second	15	5	1
6	First	4	0	0
	Second	3	0	0
15	First	11	4	0
	Second	11	0	0
16	First	7	1	0
	Second	8	1	1
17	First	5	0	0
	Second	5	0	0
19	First	9	0	0
	Second	6	0	0
20	First	5	0	0
	Second	2	0	0
21	First	8	2	0
	Second	7	1	0
22	First	2	0	0
	Second	2	0	0
23	First	14	1	0
	Second	8	0	0
24	First	7	1	0
	Second	5	0	0
25	First	12	0	0
	Second	12	0	0
27	First	4	1	0
	Second	4	0	0
28	First	7	0	0
	Second	7	1	0
29	First	2	0	0
	Second	2	0	0
30	First	4	1	0
	Second	5	0	0
33	First	11	0	0
	Second	10	0	0
40	First	9	4	1
	Second	6	1	0
41	First	14	4	1
	Second	10	1	0
45	First	3	0	0
	Second	2	0	0
46	First	4	0	0
	Second	4	0	0
48	First	4	0	0
	Second	4	0	0

animals comprised in each herd. In practice, during the absence, as now, of epidemic foot-and-mouth disease, the system is useless, but the machinery at present in existence can undoubtedly be readily utilised

for that efficient system of registration of milch goats that the Local Government will be compelled to enforce if it seriously desires to stamp out Malta Fever from the island.

Table V.—Third Examination of Certain Herds at Rabato.

No. of herd.	No. of examination.	No. of goats in herd.	No. of milks reacting.	No. of milks containing *M. melitensis*.
14	First	5	3	2
	Second.........	3	1	0
	Third	5	0	0
18	First	21	6	0
	Second.........	21	0	0
	Third	21	2	1
35	First	4	0	0
	Second.........	4	0	0
	Third	4	0	0
47	First	9	1	0
	Second.........	11	0	0
	Third	11	0	0

A further point, and one of considerable practical importance, depends upon the inconsistent results obtained at succeeding examinations, and is brought out in Table V. Taking the herds in order, at the first examination of Herd No. 14, which comprised five milch goats, the milk from three was found to give an agglutination reaction, and from two of these the micrococcus was recovered. These last two animals were removed to the Lazzaretto. At the next examination of the three remaining animals the one that had previously given a positive agglutination reaction still reacted, but the milk did not contain the coccus. At the third examination the owner had added two more milch goats, and none of the five reacted, that is to say, the reaction had disappeared from the animal that had reacted on two previous occasions.

Herd No. 18 consisted of 21 goats, including six whose milk gave a positive reaction. At the second examination none of these six reacted, while at the third examination two of those which had previously reacted again showed the reaction, and the milk of one of them now contained the specific coccus.

Herd No. 35 consisted of four healthy milch goats, none of which showed any sign of infection at the subsequent examinations.

Herd No. 47 consisted at first of nine goats, and the milk from one of them gave a positive agglutination reaction at the first examination, but a negative reaction at the second and third examinations. Subsequently the owner added two healthy animals to his herd.

These results show conclusively the necessity for repeated examina-

tions at short intervals of every herd if the detection of *all* the infective animals is aimed at.

2. *The Agglutination Test as Applied to the Milch Goat.*

The possibility that the Government of Malta might at some future period, should the infectivity of goats' milk be conclusively established, legislate on the subject, was fully appreciated in planning the observations on the milk supply of Rabato, and methods of examination were carefully investigated with a view to simplifying and systematising the routine analyses of milk that would have to be undertaken by the Public Health Department in such a contingency.

In the first place, there is no evidence that the ingestion of specific agglutinins with the milk is, *per se*, injurious to health, and the legislature would undoubtedly require the recognition of the *M. melitensis* itself in the milk as proof that such milk was noxious in character; and as in the administration of any regulation dealing with milk the frequent examination of a large number of animals would have to be undertaken, it became necessary to determine the simplest, most rapid, and most reliable method of sorting out the animals which were most likely to be passing the micrococcus in their milk before proceeding to attempt the isolation of the micro-organism by bacteriological methods.

Such a method already existed in the milk agglutination test devised by Zammit and bearing his name, a test which depends upon the fact that *M. melitensis* agglutinins, like other specific agglutinins and antibodies when present in the body in sufficient quantity, pass into the milk, and to a less extent into the urine, and can be readily demonstrated in these situations. This test, it must be stated, has limitations which form its strong feature for the purpose with which we are at present concerned.

The work carried out by the Commission in 1905 showed clearly that in presumably very remote or in very recent infections the presence of agglutinins could not be demonstrated in the milk, although they were present in the blood in sufficient quantity to yield a positive reaction in low dilutions when the blood serum was tested. On the other hand—and this is the point of practical importance—*M. melitensis* has never yet been isolated, in the present series of experiments, from a sample of milk from which the specific agglutinin was absent.

In its elemental form the test under consideration consists primarily of the admixture of equal parts of the suspected milk and an emulsion of *M. melitensis* in normal saline solution. As originally devised, it was completed in one of two ways, either by making a hanging drop preparation of the mixture and observing it microscopically after the lapse of 12 hours, or by running the mixture into capillary tubes or

sedimentation pipettes, and observing macroscopically after a similar period.

A reference to a previous part of these Reports (IV, pp. 55 and 97—98) will show that a difference of opinion existed as to the best method of performing the test, some observers preferring the hanging-drop method, others the tube method. In point of fact, both had many disadvantages.

In the microscopical method, quite apart from the difficulty of entirely preventing evaporation when the period of observation continued for so long a time as 12 hours, the difficulties introduced by the presence of masses of varying sized oil globules, which obscured all but the very large clumps, were considerable, and in the event of observations being made by partially-trained observers would undoubtedly lead to inaccurate results. These considerations early led to the rejection of this form of the test as a practical measure.

The macroscopical method was next studied, and as the perfect emulsification of the fat which obtains in goats' milk was undoubtedly the cause of the disfavour with which the test was received, a low dilution of 1 : 3 was first employed. In this series of tests numerous observations were made, carefully checking the naked eye results by running the deposit out of the capillary tube or sedimentation pipette and examining it microscopically. It was soon found that when results recorded at five hours were taken this method was a satisfactory and reliable one, but when tubes were left standing overnight the results noted in the morning were as often as not fallacious owing to the formation of a bulky deposit consisting of *débris*, leucocytes, etc., and not of clumps of *M. melitensis*.

Next was tried the effect of first converting the milk into curds and whey by the addition of rennet or of acid, separating off the curds and testing the whey. A number of experiments were made simultaneously with various samples of milk, and with whey prepared from each sample, and it became at once apparent that the agglutinins, unaltered, were present in the whey. The whey reaction was given equally well, was as definite as with clear serum, and obviously no confusion could arise with regard to pseudo reactions, due to the collection of *débris*, so that apart from the extra time and labour involved in preparation, the whey gave eminently satisfactory results.

On subsequently plating, however, it was found that cultivations prepared from whey yielded only about 10 per cent. of the number of micrococci developing from the corresponding milk sample after an identical period of incubation, a result possibly due to retention of cocci in the curd, possibly to destruction of cocci by acid.

Further dilutions of the milk itself were then tried, and finally it was determined that the most trustworthy and convenient method was to employ a dilution of 1 : 20 in capillary tubes or sedimentation

Table VI.—Comparison of the Agglutination Value of

Date	July, 21, 1906.			July 24, 1906.			July 26, 1906.			July 28, 19		
Dilution	1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1
Goat 101—												
Milk		0		+	+	−		0		+	−	[illegible]
Serum				+	+	+				+	+	[illegible]
Goat 102—												
Milk		0		−	−	−		0		+	+	[illegible]
Serum				+	+	+				+	−	[illegible]
Goat 103—												
Milk		0		−	−	−		0		−	−	[illegible]
Serum				+	+	+				+	+	[illegible]
Goat 104—												
Milk		0		+	−	−		0		+	−	[illegible]
Serum				+	−	−				+	+	[illegible]
Goat 105—												
Milk		0		+	+	+		0		+	+	[illegible]
Serum				+	+	+				+	−	[illegible]
Goat 106—												
Milk		0		+	+	+		0		+	+	[illegible]
Serum				−	−	−				−	−	[illegible]
Goat 108—												
Milk		0		+	+	−		0		+	−	[illegible]
Serum				+	+	+				+	+	[illegible]
Goat 110—												
Milk	+	+	±		0		+	−	−		0	
Serum	+	+	+				+	+	+			
Goat 111—												
Milk	+	+	±		0		+	±	±		0	
Serum	+	+	±				+	+	+			
Goat 112—												
Milk	+	+	+		0		+	±	±		0	
Serum	−	−	−				−	−	−			
Goat 113—												
Milk	+	+	+		0		+	+	+		0	
Serum	+	+	+				+	+	−			
Goat 114—												
Milk	+	±	±		0		+	+	±		0	
Serum	+	+	+				+	+	+			
Goat 115—												
Milk	+	+	−		0		+	+	+		0	
Serum	±	±	−				+	−	−			
Goat 117—												
Milk	+	+	−		0		+	+	+		0	
Serum	+	+	−				+	−	−			
Goat 118—												
Milk	+	−	−		0		+	+	−		0	
Serum	+	−	−				+	+	−			
Sheep 107—												
Milk		0		+	+	−		0		+	−	−
Serum				+	+	+				+	+	+

0 = not examined.

[an]d Blood Serum in the Infected Milch Goat and Sheep.

July 31, 1906.			August 2, 1906.			August 4, 1906.			August 7, 1906.		
1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1 : 100
	0		+	−	−		0		+	+	−
			+	+	+				+	−	−
	0		−	−	−		0		+	±	±
			+	+	−				−	−	−
	0		−	−	−		0		+	+	−
			+	+	−				+	+	+
	0		+	−	−		0		±	±	−
			−	−	−				+	+	+
	0		+	−	−		0		+	+	−
			+	−	−				−	−	−
	0		+	+	−		0		+	−	−
			+	+	+				−	−	−
	0		+	−	−		0		+	+	+
			+	+	+				+	+	+
+	−	−		0		+	+	+		0	
+	+	+				+	+	+			
+	+	±		0		+	+	±		0	
+	−	−				+	+	+			
±	−	−		0		+	−	−		0	
−	−	−				+	−	−			
+	+	+		0		+	+	+		0	
+	+	+				+	+	+			
+	−	−		0		+	+	+		0	
+	+	+				+	+	+			
+	±	±		0		+	+	+		0	
+	+	+				+	+	+			
+	−	−		0		+	+	−		0	
+	−	−				+	+	+			
−	−	−		0		+	−	−		0	
+	+	+				+	−	−			
	0		±	−	−		0		+	+	+
			+	+	−				+	+	+

0 = not examined.

pipettes with a time limit of 24 hours—a method carried out in actual practice by mixing equal volumes of a 1 : 10 dilution of milk with the previously prepared emulsion of *M. melitensis* in distilled water. Under these conditions the fluid is sufficiently clear to show the reaction quite as definitely as in the case of blood serum, while the specific gravity is so altered that the fat globules are very quickly disentangled and rise to the upper part of the column of fluid as cream, and the risk of pseudo reactions from sedimentation of *débris* is avoided.

By repeated experiments it was found that where a true reaction was yielded by the low dilution method (1 : 3), a reaction was obtained in 1 : 20 dilution; but on carrying the dilution higher it was found that milks giving a positive reaction in 1 : 3 and in 1 : 20, and which on plating yielded *M. melitensis* in some instances, gave a negative reaction in 1 : 50.

Moreover, it was found that in the case of sheep the low dilution (1 : 3) did not give reliable results owing to the opacity of the milk; whilst with a 1 : 20 dilution consistent and reliable results were obtained.

The test as thus modified has now been in use for many months, and the best criterion of its utility is summed up by the fact that *M. melitensis* has never been isolated from or detected in a sample of milk which yielded a negative reaction.

It was also noted during the course of these experiments as a general, but far from invariable, rule, that those milks which gave a good sedimentation reaction immediately upon mixing with the bacterial emulsion, or within an hour or two, were more likely to yield cultivations of *M. melitensis* on plating than those which required the full 24 hours for the completion of the reaction.

A comparison of the milk agglutination reaction with the blood agglutination reaction of the infected goat naturally formed part of these experiments with the "Zammit test."

The milk and blood samples were collected at the same time, the test applied with the same bacterial emulsion, and identical dilutions of 1 : 20, 1 : 50, and 1 : 100 were employed in each case.

Roughly speaking, the reactions are comparable: on the whole the blood frequently reacts in higher dilutions than the milk, though in some instances the opposite holds good. In two animals (Goats Nos. 106 and 112) the milk reacted in 1 : 20 when agglutinins appeared to be absent from the blood; in a third (Goat No. 103) the converse obtained, the milk did not react in 1 : 20, while the blood did so. No relationship whatever could be deduced between the intensity of the reaction and the numbers of *M. melitensis* present in the milk. A number of these observations are tabulated on pp. 16 and 17.

The table shows, too, in a most marked manner, the periodic

variation in the agglutination value of the serum, the curve of which is closely followed by that of the milk, due no doubt to auto-inoculation or auto-vaccination with living *M. melitensis* taking place in milch goats which are still the subject of a subacute systemic and generalised infection—an explanation which accords well with observed facts, and which is supported by the results of observations made upon milch goats which were under treatment with vaccine prepared from dead cultures of *M. melitensis.*

3. *The Numerical Relationship of* M. melitensis *to the Milk of Infected Goats.*

As it had already been noted that the milk from an infected goat varied greatly from day to day in its potentialities for evil—that is to say, milk which contained many thousands of individual *M. melitensis* per cubic centimetre when examined one day, at the next examination a few days later, or even on the following day, might be apparently free from the micro-organism, and again in a few more days might be crowded with the cocci—systematic observations were commenced to determine, if possible, whether some definite periodic variation, seasonal or otherwise, existed. These observations are as yet incomplete, but the results of nearly four months' work are available, and on account of their interest are inserted here.

The results show that although the excretion of *M. melitensis* in the milk during some stages of the infection is persistent, it is by no means constant or even consistent; nor—premising that all the observations now recorded were carried out during the so-called summer—was it possible to determine any correlation between the temperature curve and the number of cocci excreted in the milk (*vide* Fig. 2, p. 24). The observations which are being continued throughout the winter may, however, afford further information in this connection when completed. The animals affording material for the enquiry were comprised in a herd of 17 milch goats and 1 milch sheep belonging to the Commission and stalled in the Lazzaretto. Twice and often three times a week a specimen of milk was collected from each animal, immediately conveyed to the Laboratory at Valletta, and there plated out. On account of the extreme variation noted in the numbers developing per cubic centimetre from each animal's milk, together with the necessity for examining the milks from a number of animals each day, it was a matter of some difficulty to decide on the amount of milk to be plated for each examination. After many experiments in this direction 0·035 c.c.—an amount equivalent in bulk to a single drop falling by gravity from the end of a fine capillary pipette—was decided upon, and three plates were inseminated, each with this quantity of milk, from every goat at each examination. In plating, the milk was deposited on the centre of

a nutrose-agar plate and distributed all over the surface by means of a sterile L-shaped glass rod spreader. After suitable incubation, the colonies of *M. melitensis* that had developed on each of the three plates were enumerated and averaged, the contents per cubic centimetre calculated and the results obtained recorded in tabular form, and also plotted in a curve.

Table VII.—Numerical Strength of *M. melitensis* per cubic centimetre in Mil Infected Goats.

Serial No. of goat	104.	105.	106.	107.	111.	112.	114.	115.	
1906—									
May 7...	4,000	nil	330	7,000	—	—	—	—	
" 10...	800	30,000	200	?	15,000	100	—	—	
" 15...	13,000	nil	nil	2,400	6,000	nil	—	—	
" 22...	30,000	nil	nil	6,000	30,000	nil	—	—	
" 26...	3,000	nil	nil	4,000	6,000	4,000	—	—	
" 29...	30	nil	nil	4,600	15,000	nil	—	—	
" 31...	nil	nil	nil	6,500	30,000	100	nil	6,000	
June 2...	66	nil	nil	10,000	5,700	nil	30,000	15,000	
" 5...	7,500	nil	nil	6,000	12,000	30	4,300	30,000	3
" 9...	nil	nil	nil	nil	20,000	nil	?	4,600	
" 12...	830	nil	nil	7,300	3,400	66	nil	30,000	3
" 14...	nil	5,000	nil	10,000	8,000	100	1,760	5,500	3
" 16...	66	nil	nil	500	6,000	30	14,000	100	
" 19...	nil	nil	nil	nil	30,000	700	700	430	
" 21...	30	nil	nil	30	2,400	2,000	nil	23,000	
" 23...	130	nil	2,000	5,000	2,700	3,200	1,500	660	
" 26...	66	nil	2,000	15,000	13,000	30,000	20,000	1,000	1
" 28...	200	nil	nil	30,000	12,000	2,600	15,000	2,500	2
" 30...	1,500	30	400	30,000	23,000	1,000	18,000	4,700	2
July 3...	1,100	nil	330	3,000	6,170	66	16,000	8,000	3
" 5...	400	nil	30	2,400	4,000	66	20,000	17,000	2
" 19...	700	10,000	nil	23,000	—	—	—	—	
" 21...	—	—	—	—	730	nil	15,000	30,000	3
" 24...	470	8,300	nil	2,300	—	—	—	—	
" 26...	—	—	—	—	1,000	nil	4,000	20,000	2
" 27...	—	—	—	—	4,000	—	800	300	
" 28...	66	nil	nil	1,700	—	—	—	—	
" 31...	—	—	—	—	30	nil	30,000	1,700	1
Aug. 2...	16,000	1,200	nil	1,800	—	—	—	—	2
" 4...	—	—	—	—	2,700	nil	3,000	730	
" 7...	660	5,300	100	1,000	—	—	—	—	
" 14...	1,600	nil	540	20,000	nil	nil	nil	8,000	30
" 18...	750	6,600	nil	720	10,000	nil	6,000	nil	

— = not examined.

In connection with this table a fallacy and an inaccuracy must be pointed out. In the first place, the fallacy consists in recording *nil* per cubic centimetre, when only three separate small amounts of milk—totalling in the aggregate but a little more than 0·1 c.c.—proved to be sterile or had failed to give rise to a single colony of *M. melitensis*.

Such a result, however, is amply sufficient to show that the *M. melitensis* content of the milk is extremely small, and, bearing this fallacy in mind, it is sufficiently accurate for the purposes of a comparative table to record such a result as *nil.* The inaccuracy relates to the other extreme. In enumerating colonies on a plate it is usual to count each individual colony, when the number does not exceed 1,000, by the help of radii drawn on the bottom of the glass dish with a grease pencil. Beyond this figure it is customary to observe the colonies by the aid of a low power objective, to enumerate those enclosed in several areas of the plate, and average the contents of such areas. For this purpose a 1-inch or a $\frac{2}{3}$-inch objective, a suitable eye-piece and such particular length of tube is employed as will produce a field whose area bears a definite relationship to the total area of the plate, so that finally the approximate content of the entire plate is rapidly calculated from the content of an average field. The recorded figures between 100 and 1,000 may therefore be regarded as accurate; figures in excess of 1,000 calculated from the average contents of selected microscopical fields are probably highly inaccurate; but as in all these estimations care was taken to select the fields for counting from the least crowded portions of the plates the inaccuracy was always in the direction of underestimation. In some instances so obvious was the underestimation that 30,000, the highest figure recorded—as it was necessary to keep the curves that are presented herewith (see Fig. 2) within reasonable limits—is indicated in special type to show that, in the opinion of the observers, at least one other zero should be added, as the numbers were practically uncountable.

This difficulty in enumeration will be better appreciated by a glance at Fig. 1, which represents a plate inoculated with 0·035 c.c. of milk from Goat No. 111. With the exception of the few large colonies of saprophytic bacteria, all the colonies are due to the growth of *M. melitensis.* The milk from which this plate was prepared is returned as containing **30,000** *M. melitensis* per cubic centimetre.

On several occasions control plates were prepared with suitable dilutions of the milk samples, and it was frequently found that 3,000,000 per cubic centimetre would be much nearer the true content of the milk than the 30,000 recorded.

In this connection it may be remarked that the conditions under which work with goats' milk is carried out in Malta are totally different from those that hold in England, when the corresponding food, cows' milk, is being investigated. It must be obvious to those who are in the habit of working with cows' milk at home, that the enumeration of colonies of any specific organism, *e.g.*, streptococci, in plates prepared by smearing milk direct upon the surface of the medium, would be a hopeless task on account of the number of extraneous saprophytes present. With the Maltese goat, however,

having discarded the first few cubic centimetres of fore milk, the next quantum, the mid milk and the strippings, consist of sterile, or practically sterile, milk, in the case of the normally healthy milch goat, or a pure culture of *M. melitensis* in the case of the milch goat which is infected by *M. melitensis* and is voiding the germ in its milk. Some of the reasons for the clean character of the milk are fairly patent,

FIG. 1.—Nutrose agar plate prepared from 0·035 c.c. freshly drawn milk from Goat 111. All the minute colonies are composed of *M. melitensis*.

although the goat is an extremely dirty animal in its choice both of food and resting-place. Most important of all is the fact that the milk is examined within a very short time of its removal from the mammary gland of the goat—no long interval, occupied in transit by road and rail, is allowed for the multiplication of extraneous saprophytes. Again, in milking, the goatherd invariably crouches

directly behind the animal, and grasping the udder, drags it back between the hind legs, which the animal separates widely to allow of its passage. The receptacle for the milk, if small, is held in one hand some distance behind the animal and below the level of the teat, while the other hand, grasping udder and teat, directs an oblique stream of milk into it—in other words, the jet of milk and the receiving vessel hold the same relative positions as the inoculating platinum needle, and the test-tube respectively, when a tube culture is being prepared in the laboratory. If the receptacle for the milk is large, it is placed on the ground behind and well clear of the goat, and the goatherd, employing both hands, milks from both teats; consequently, any dirt and filth dropping from the udder and hindquarters falls more or less vertically to the ground, while the stream of milk traverses a stratum of clean air which does not usually add saprophytes to the milk during its passage; indeed, the freedom of the air and dust from saprophytic bacteria is a noteworthy feature of bacteriological research in Malta, and is due no doubt to the sterilising action of the direct rays of the sun—which are available for at least 12 hours per diem for the greater part of the year. Aerial contamination of cultivations in a laboratory kept moderately clean is rare, plate cultures can be made in the open air with a reasonable certainty that, where not intentionally infected, they will remain sterile, and plates may be opened and examined day after day without the preparations becoming contaminated.

For the moment the only explanation that can be offered of this day-to-day variation in the number of cocci present in the milk is that the micro-organism, lodged in a suitable soil and richly supplied with a medium of high nutritive value, multiplies rapidly in the interstices between and upon the surface of the gland epithelium cells. This multiplication proceeds up to a certain point, when, owing perhaps to the mechanical irritation set up by the mere presence of the coccus, a flushing process is carried out by the milk itself which removes the excess of cocci and leaves behind in the gland tissue only those cocci which are in intimate relationship with the gland cells. A certain interval necessary for the further multiplication of those cocci left behind elapses, then the process is again repeated, and so on.

Conversely, it is more than probable that the stimulus provided by the presence of the bodies of the cocci, or of their toxins, is an important factor in the large and long-continued milk yield of the infected milch goat.

In the accompanying Graph, the numbers of *M. melitensis* obtained at the periodic examinations of the milk from Goats 111, 114, 117 are plotted out in curves superposed on the curve representing the diurnal mean temperature of the air of Valletta. On the one hand, it will be seen that there is no direct association between discharge of cocci in the milk and rise or fall of air temperature; on the other, the

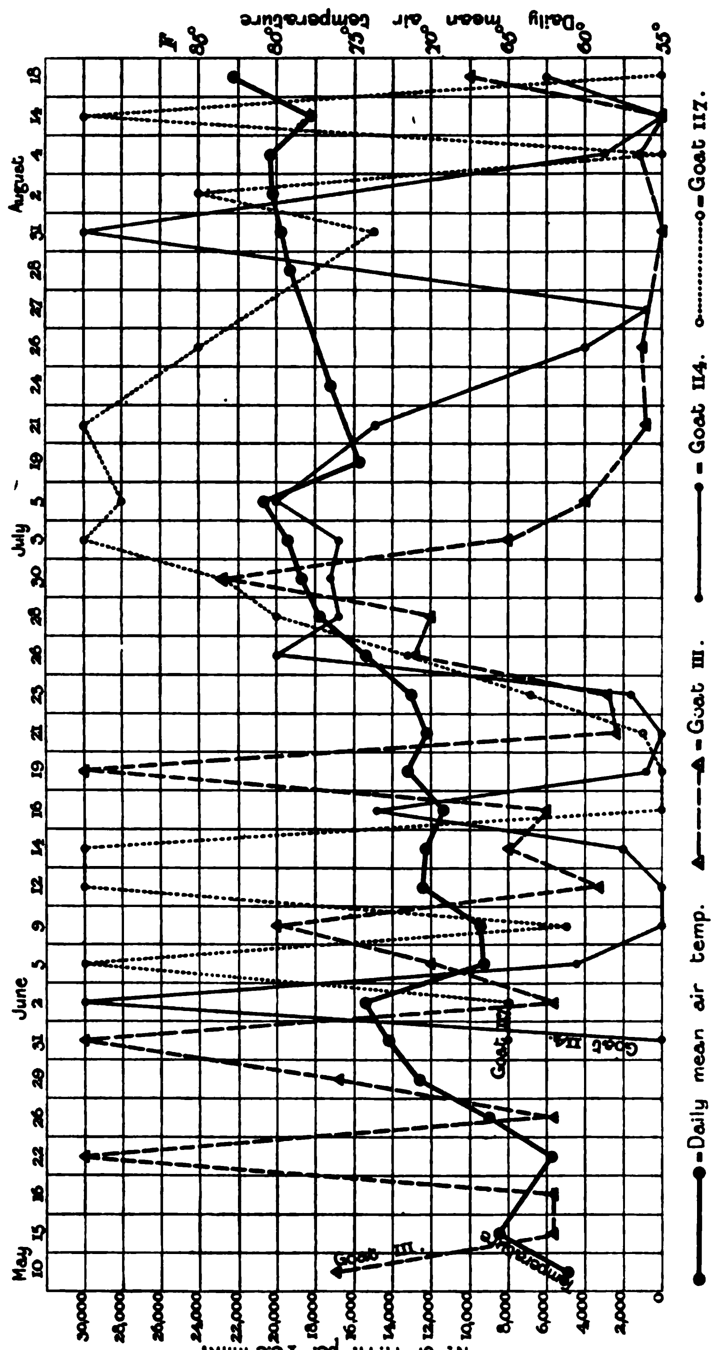


Fig. 2.—Curves showing the periodic variation in the *M. melitensis* content of milk of infected goats.

periodic discharge of large quantities of cocci and the variable interval during which but few cocci are present in the milk, are well brought out.

4. *The Presence of* M. melitensis *in Milk Products.*

The fact elicited as the result of the examination of a very large number of animals, that at least 10 per cent. of the milch goats in the Island of Malta secrete milk which contains the specific germ of Malta Fever in divers quantities, rendered it extremely likely that the micrococcus might pass unscathed through the various manipulations to which milk is subjected in the preparation of articles of food such as cheese, etc., and some observations were accordingly made in this connection.

Cheese.—The native cheese in common use is a whole milk cheese, and is prepared in a very simple and primitive manner. Acid or rennet is added to the sheep's or goat's milk, and the resulting curd is "set" in open basketwork moulds which allow the whey to drain off, placed aside overnight, and is ready for consumption the following day. Such a cheese is, of course, eaten fresh, as its method of preparation hardly fits it for prolonged storage.

At first sight it would appear probable that the high degree of acidity present in the cheese (a fair average would be + 80 or + 90 as compared with an optimum of + 8 or + 10 aimed at in preparing nutrient media for the cultivation of *M. melitensis*) would ensure the destruction of the micrococcus. A reference, however, to the work of Shaw* shows that the micrococcus can retain its vitality in urine, having a reaction of + 40, + 50, or + 60; and, again, it was noted in carrying out certain experiments as to the presence of agglutinins and of the specific coccus in whey, prepared from infected milk, that the coccus retains its vitality in this highly acid whey, while the diminution in number in this whey as compared with the original milk would suggest that numerous cocci remain entangled in the curd, quite as much as that numerous cocci are killed off by the acid present.

The first sample of cheese to be examined was obtained 24 hours after setting, direct from its manufacturer, a peasant farmer near Zebbug, who kept a herd of 13 milch goats and one milch sheep. (Seven of his goats, the sheep and a sow were subsequently found to be infected, and the goats and sheep were secreting milk containing *M. melitensis*. These animals, purchased by the Commission and lodged in the Lazzaretto, afforded material for many of the observations recorded in the previous pages.)

Plate cultivations in series on the surface of nutrose-agar were established in the usual way from pieces cut from the centre of the

* These Reports, III, p. 43 *et seq.*

cheese with a sterile knife, after well searing the surface with a red-hot iron: and also from 0·1 c.c. of an emulsion prepared by breaking up approximately 0·1 gramme of cheese in 10 c.c. of sterile broth. Three plates only were prepared in each series, and after incubation it was found that the dilution was insufficient, as all were crowded with saprophytic bacteria which rendered the "fishing" of the colonies of *M. melitensis*, which were recognised with the hand lens, a matter of impossibility. Scrapings from the plate, which included colonies of the coccus as well as neighbouring saprophytes, when emulsified in distilled water and added to a 1 in 250 dilution of specific serum, showed microscopically typical clumps of *M. melitensis*. Ordinary sub-cultures failed to give a growth of the micrococcus, and as it was considered waste of time to continue work on this cheese, the plates were abandoned and further experiments made with cheeses prepared in the Lazzaretto from the milk of the identical infected sheep and goats—now the property of the Commission—from which this first specimen had been manufactured.

Numerous cheeses were made and each examined repeatedly during several days, and it was found that by careful attention to the question of dilution in preparing the series of plates, it was a fairly easy matter to isolate the coccus from the cheese up to the end of 48 hours. After this time the multiplication of lactic acid and other bacteria outstripped that of *M. melitensis*, and it was no longer possible to recover the organism.

Ice Cream.—With the advent of hot weather, soon followed by the discovery that the ordinary private soldier does purchase ice-creams in the local cafés and consume them, attention was directed to this milk product. Enquiry elicited the fact that, as in England, two varieties of ice-cream are in vogue, the one prepared by freezing a flavoured custard of milk and eggs previously heated to about 80° or 90° C. and cooled, the other by flavouring milk to which cream may or may not be added, with various essences or syrups and freezing—the former being the more expensive. As by this time the infectivity of goats' milk was becoming a matter of common knowledge among the Restauranteurs of Malta, one individual volunteered the information that he always boiled his goats' milk before using it in the manufacture of ice-cream. On the other hand, it has been stated by a private in the Royal Army Medical Corps that a café keeper who had run out of his stock of ices would milk the goat tied up to his door post, and some 20 minutes later produce the ice-cream to his customer.

Experimental ice-creams of both types were, therefore, prepared in the laboratory from milk derived from the infected herd at the Lazzaretto, and then examined for the presence of the *M. melitensis*. In the case of those made from a custard of milk, eggs, and sugar, and heated to about 80° C. to ensure the thorough incorporation of

the ingredients, it was found impossible to recover living *M. melitensis*, although it was known they were present in abundance in the infected milk—from the result of plate cultivations established prior to heating. This was only to be expected, as the thermal death point of the organism in watery suspension has been determined as 57·5° C.

In the case, however, of the second type of cream where no heating is resorted to, it was found to be as easy to recover *M. melitensis* from such as had been prepared from infected milk as it was from the milk itself.

With these data to work upon, a series of examinations of samples of ices from various cafés was instituted. The ice-cream, on arrival in the laboratory, was placed in the incubator at 37° C. for an hour or two to thaw. The ortol and peroxide of hydrogen test* was next applied to determine whether or no the milk had been boiled or had been heated above 70° C., although often ocular observation was sufficient in the case of such as had been prepared from custard. In the event of the sample of cream having been made from custard, the specimen was, of course, discarded, but if it responded to the test and gave the characteristic reaction associated with unheated milk, then plate cultivations in series were established from the cream and set aside in the incubator. Some of the fluid portion of the ice-cream was diluted to 1 in 10, with sterile water added to an equal quantity of emulsion of *M. melitensis*, taken up in sedimentation tubes and set aside for observation as to the presence or absence of agglutinins.

If, on the following morning, the sedimentation reaction was absent, the plates made from that particular ice-cream were discarded, as previous experiments in this connection (p. 18) had shown that *M. melitensis* was never recovered from milk in the absence of a good agglutination reaction in dilution of 1 in 20.

In all, 11 samples of retail ice-creams were examined before illness interfered with the investigation. Three had been prepared from heated custard, and were consequently discarded; four others, prepared from unheated milk, were plated out, but as on the following morning the sedimentation reaction was absent, these plates were not proceeded with. The four remaining samples—made from unheated milk—yielded a complete sedimentation reaction, and the plates

* This is a test introduced by Saul some few years ago, and depends upon the fact that the addition of ortho-methyl-aminophenol sulphate (or of ortol, an impure preparation of the same salt, used chiefly in photographic work) to raw milk in the presence of nascent oxygen, gives rise to a brick-red coloration within 30 seconds of mixing. With milk which has been heated at or above 70° C., no change is observed.

In practice the test is carried out by adding 1 c.c. of a freshly prepared aqueous solution of ortol (1 per cent.) to 10 c.c. of milk in a test-tube and then adding one or two drops of hydrogen peroxide (3 vols.).

prepared from them were carefully worked out, but with negative results; *M. melitensis* could not be detected.

Further investigations in this direction are now in course of prosecution.

Butter.—As practically all the butter consumed in the island is imported tinned butter and margarine, no examinations of samples of this food were made.

5. *Susceptibility of the Goat to, and Paths of Infection by* M. melitensis.

As the results of the examination during the years 1905 and 1906 of a very large number of animals scattered throughout the island had revealed the fact that, roughly, some 10 per cent. of the milch goats were secreting milk containing the coccus, while some 30 per cent. more by the existence of fair quantities of specific agglutinins in the blood serum and milk afforded the strongest presumptive evidence of previous infection, it is obvious that the goat is distinctly susceptible to the pathogenetic influence of *M. melitensis.* The experimental work carried out during the same years also showed clearly that the goat could be infected, with a fair amount of ease, by the ordinary laboratory methods of inoculation—that is by the subcutaneous and intravenous injection of living cultivations of *M. melitensis*—and also by feeding, either with artificially or naturally infected material.

These observations rendered any extended series of experiments in similar directions needless; on the other hand, no experimental results were available with regard to infection by contact, such as had already been shown took place in the case of monkeys in close proximity to each other.*

Contact Infection.—Two yearling female goats—Nos. 22/5 and 23/5—which had not yet been impregnated, and consequently were not "in milk," and from whose blood specific agglutinins were absent, were, therefore, turned loose into a large stable in company with 16 infected milch goats and one infected milch sheep, from all of whose milk *M. melitensis* was obtainable in varying numbers. None of the animals were tethered; consequently the contact was as intimate as possible, while the fact that neither of the two experimental animals were included in the daily milkings eliminated the likelihood of transmission of infection viâ the goatherds' hands. Eight days after the commencement of the experiment the blood serum of Goat No. 23/5 yielded a partial agglutination reaction in a dilution of 1 in 10; on the following day the serum from Goat No. 22/5 gave a similar result, and on the 16th day both goats gave a complete positive agglutination reaction in dilutions 1 in 10 and

* *Vide* these Reports, I, p. 67.

1 in 20. Subsequent examination of the blood serum from each goat showed those fluctuations of the agglutination curve that are usually associated with *M. melitensis* infections, and the serum value six weeks after the commencement of the contact reached 1 in 100. At the end of four and a-half months both goats were killed and examined *post-mortem*. The organs that were examined after death were spleen, inguinal glands, mesenteric glands, and kidneys, and from none of these was *M. melitensis* recovered. This failure to detect the specific micro-organism *post-mortem* in the case of infected goats has by no means the same significance that it would have in other experimental animals, a point which will be referred to in a succeeding section.

In this experiment infection may have taken place through actual contact, the ingestion of fodder saturated with infective milk or urine, convection by ordinary flies, transmission of the coccus by means of biting flies, etc., the conveyance of infective material on the goatherds' hands alone being eliminated.

Of the various methods above mentioned, it may be pointed out that some would be excluded under ordinary circumstances. For instance, in the native goat-house the goats are usually tied up on either side of a raised trough containing food, from which few or many feed in common, by a length of rope sufficient to permit of the animal lying down. Each animal retains the same position from day to day; consequently contact in the stable is limited to the neighbouring goats on either side, and when the troughs are arranged in rows to the animal immediately behind also, and it is a noteworthy fact that in many cases it is either the next-door neighbour or the goat immediately behind the infected goat that next becomes infected, and not the goat on the opposite side of the trough. When taken out of the goat-house to start on the daily milk round, contact is more promiscuous, though here, again, stable companions are said to keep together.

Subcutaneous Infection.—It next appeared desirable to determine whether comparatively small doses of living cocci from artificial cultivations could be depended upon to produce infection. For this purpose four normal, healthy, young kids were selected, and when repeated observations had shown that specific agglutinins were absent from the blood, they were injected subcutaneously, each with a different sized dose of infective material.

The strain of *M. melitensis* employed for the experiment was a first sub-culture (from a single colony) of the coccus isolated from the milk of Goat No. 111—one of the infected milch goats under observation in the Lazzaretto.

The actual culture used was a 48-hours agar-tube growth. One loopful*

* An ordinary agar slope cultivation would be equivalent, approximately, to 50 such loopfuls.

Table VIII.—Inoculation Experiments with the Goat.

No. of goat.	Sex.	No. of cocci injected.	Bulk of infective emulsion.	Method of inoculation.	Serum reaction. Day of appearance.	Serum reaction. Amount of dilution.	Duration of experiment in days.	Post-mortem findings. Value of serum.	*M. melitensis* recovered from— 10 c. mm. of blood.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
10	♂	10,000,000	c.c. 1·0	Subcutaneously at root of left ear.	7	1 : 20	47	1 : 200	−	+	+	−	+
9	♂	1,000,000	0·1		7	1 : 20	47	1 : 100	−	+	−	+	+
5	♀	100,000	0·01		17	1 : 20	46	1 : 20	−	−	−	−	+
4	♀	10,000	0·001		17	1 : 10	46	1 : 20	−	−	−	−	+

of this growth was emulsified in 10 c.c. of sterile saline solution, and the four goats were inoculated subcutaneously at the root of the left ear with 1, 0·1, 0·01, and 0·001 c.c. respectively of the emulsion. Portions of the remainder of the emulsion, after suitable dilution, were plated out and incubated. Enumeration of the resulting colonies showed that the emulsion contained 10,000,000 cocci per cubic centimetre.

Consequent upon these injections all four goats became infected: the blood serum from the first and second yielding a positive agglutination reaction with 1 in 10 and 1 in 20 dilutions on the seventh day. Serum from the third did not give a positive reaction until the seventeenth day in these dilutions, whilst the fourth, although giving a positive reaction in 1 in 10 dilution, gave an incomplete reaction only with 1 in 20 on the seventeenth day, and not until the thirtieth day did the serum react well with 1 in 20 dilution.

From the clinical point of view there is little to record in connection with these inoculated goats. At no time during the course of the experiment did either of the goats appear to be ill—their coats were in good condition, no glandular enlargement was to be observed on palpation, and the animals fed well, as usual. The temperature was somewhat irregular, but in this respect none differed markedly from the healthy animals that served as controls, as will be seen from the temperature charts (*vide* p. 32) of the four experimental animals and the one of the normal animals in an adjoining stable that showed the least extensive excursions from the normal line (which for the goat averages, according to Damant,* 103·5—104° F.), and so served as a control.

All the animals were killed at the end of six weeks, and at the *post-mortem* inspection ample evidence of *M. melitensis* infection was available in the recovery of the organism from the spleen in all four goats, and in three of them from other organs as well. Details of this experiment are shown in tabular form (see Table VIII).

A point of some interest may be noted in this experiment with regard to the relationship of the size of the dose of infective material to the date of onset of signs of infection. Thus the two first goats, which received 10 and 1 million cocci respectively, gave evidence of reaction to the infection, by the appearance of specific agglutinins in the blood, within a week of inoculation and a full 10 days earlier than the other two goats which had each received less than a million cocci.

Cutaneous Infection.—The suspicion that had been aroused with reference to the probability of infection being carried from goat to goat by way of the goatherd's hands when soiled with infective milk was strengthened by the knowledge that such a comparatively small amount of infective material injected subcutaneously was sufficient to produce infection.

The technique adopted by the Maltese milker closely resembles

* 'Journ. Physiol.,' Cambridge, 35, 1906 (Proceedings, v).

Chart No. 1.

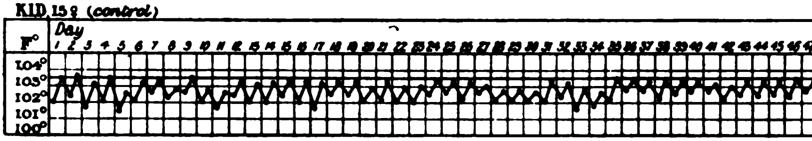


Chart No. 2.

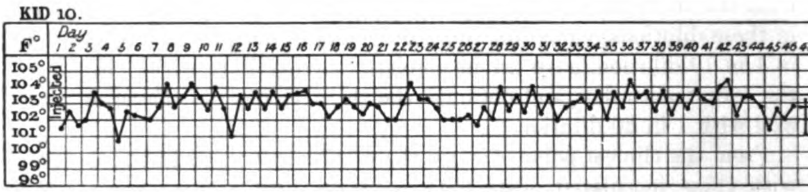


Chart No. 3.

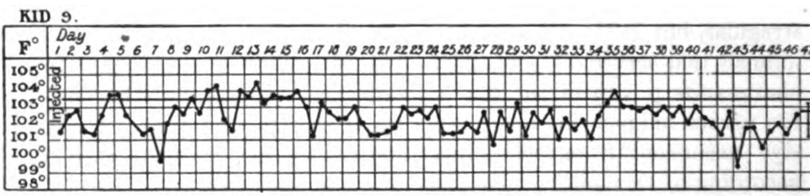


Chart No. 4.

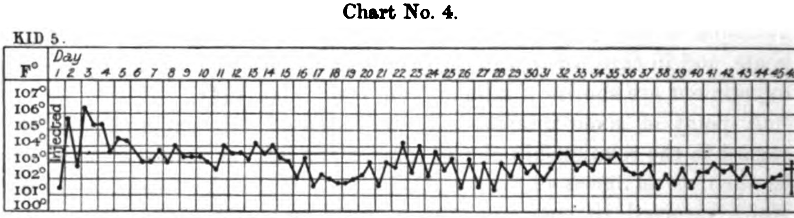
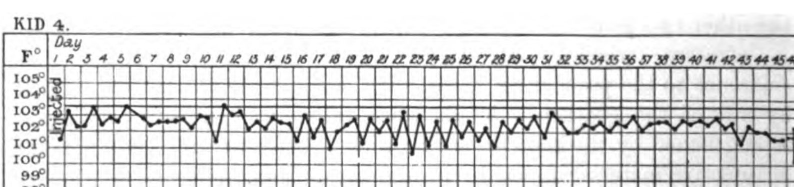


Chart No. 5.



Subcutaneous Infection of the Goat.

that of his English confrère, and consists in lubricating his own hands and the outside of the udder with some of the foremilk. When a number of goats have to be milked in rapid succession, the lubricant obtained from the first goat will serve for perhaps some half-dozen goats; with the seventh goat a fresh supply of milk is taken for the same purpose, and so on. Now, given that Goat No. 1 or Goat No. 7 is passing *M. melitensis* in its milk, it is obvious that, at any rate, Goat No. 2 or No. 8, as the case may be, stands a very good chance of becoming infected by a process of subcutaneous inoculation; consequently steps were taken to investigate the possibility of this occurrence.

In carrying out this experiment, the procedure of the goatherd was imitated as closely as possible, and Goat No. 25/6, a healthy female, nearly full grown, was selected for the purpose of the experiment, cast on an operating table and securely held by assistants. A fairly large area of skin over the left mammary gland was shaved somewhat roughly, in such a manner as to remove in many places the superficial layer of epithelium as well as the hair, but care was taken to avoid drawing blood. Thus the shaved area replaced the scratches, abrasions, and small ulcers that are so frequently seen in the udder and teats of the milch goat.

Next, the hands of the operator being protected by a pair of sterilised indiarubber gloves, four drops of freshly-drawn milk from Goat No. 117 (amounting in total bulk to 0·2 c.c.) were delivered into the palm of the right hand from a sterile capillary pipette, and then thoroughly rubbed into the shaved area with movements similar to those practised by the goatherd as a preliminary to milking. The quantity of milk used was so small that the skin surface rapidly dried, and the goat was then isolated in a stall apart from the other animals. Immediately after the experiment was concluded, a sample of the milk that had been used was carefully plated out (after suitable dilution) and found to contain 24,800 *M. melitensis* per cubic centimetre; the approximate number of cocci, therefore, that came into contact with the prepared area of skin amounted to 5,600.

Samples of blood were taken from a vein in the ear of this animal and examined from day to day for the presence of specific agglutinins, which first made their appearance on the fifteenth day (dilutions 1 in 10 and 1 in 20).

Three weeks after inoculation the goat was killed and a careful *post-mortem* examination carried out, with the result that the specific organism was recovered from the spleen and inguinal glands.

At the same time Goat No. 23/6, a four-month-old female kid which appeared quite healthy, was selected as a control. The skin over the mammary gland was carefully examined with a hand lens, and an area quite free from scratches, cracks, or fissures was isolated by painting flexile collodion on the surrounding skin. Eight drops of milk from

Table IX.—Cutaneous Inoculation of the Goat with *M. melitensis*.

No. of goat.	Sex.	No. of cocci inoculated.	Bulk of infective milk.	Method of inoculation.	Serum reaction.		Duration of experiment in days.	*Post-mortem* findings.					
								Value of serum.	*M. melitensis* recovered from—				
					Day of appearance.	Amount of dilution.			10 c. mm. of blood.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
			c.c.										
25	♀	5,600	0·2	Infective milk rubbed into prepared area of skin.	15	1 : 20	20	1 : 100	–	+	+	–	+
23	♀	11,200	0·4		—	—	18	—	–	–	–	–	–
Cf. also Monkey No. 188	♂	13,250	0·2		13	1 : 50	17	1 : 200	+	+	+	+	+

Goat No. 117 was then deposited on the centre of the prepared area and rubbed into the skin with the top of the forefinger—still protected by the rubber gloves. When dry, the kid was released, isolated in a separate stall, and subsequently specimens of blood were examined from time to time with negative results until the eighteenth day after inoculation, when the kid, which had been refusing its food for nearly a week, died.

According to the animal attendants, death was due to the fact that an inferior batch of fodder, on which it had been feeding, was an unsuitable food for so young a goat. Be this as it may, at the *post-mortem* examination, beyond absence of fat and emaciation, no obvious cause for death could be detected. *M. melitensis* could not be found in any of the organs nor in the subcutaneous tissue or skin at the seat of inoculation, and specific agglutinins were absent from the blood serum.

The successful result attending the cutaneous method of inoculation in the case of Goat No. 25/6—a method closely resembling that employed in Jennerian vaccination—renders it extremely probable that convection by the flies which positively swarm in the goat pens, may play a part in the transmission of the infection from goat to goat. First settling on drops of infective milk or urine, soiling body and legs, as well as proboscis, and then flying to a scratch or friction ulcer on a previously healthy goat, whether on udder or other part of the body, it would be a very easy matter for the fly to deposit a sufficient number of *M. melitensis* on the raw surface to ensure infection.

The result of the foregoing experiments, together with some observations made in connection with inoculation through the apparently uninjured mucous membrane of the external genitals of the monkey (*vide* p. 113), render the probability of infection of the goat during impregnation extremely likely—a probability which, so far as the male is concerned, is rendered still more likely owing to the fact that the female urethra opens into the floor of the vagina a couple of centimetres or more within the orifice of the canal, so that when the animal is passing *M. melitensis* in the urinary excretion the coccus must be present near the mouth of the vagina in considerable numbers. Unfortunately it was not feasible to test this method of infection experimentally, for, although numerous healthy and infected males were forthcoming, the late season rendered efforts to secure healthy and infected females in suitable condition for such experiment fruitless.

Transmission of the coccus by means of blood-sucking flies, other than by mechanical conveyance upon body or limbs, for example, by *Stomoxys calcitrans*—which abounds in the goat stalls—appeared from the experiments carried out during the summer to be extremely improbable. The negative results obtained in this connection are detailed later (see p. 99).

6. *The Localisation of* M. melitensis *in the Infected Goat.*

Inoculation of the goat with *M. melitensis* produces what must be regarded as an acute, or more commonly a sub-acute, septicæmia—the specific organism living and multiplying in the circulating blood for a variable, often a considerable period—which but rarely proceeds to a fatal termination.

Except on rare occasions when for the few days immediately following inoculation the temperature is raised, the constitutional disturbance accompanying infection is but little marked, and soon ceases to be demonstrable; later on the presence of the specific organism can be detected in excretions and secretions, viz., the urine or milk, or both; but these phenomena are by no means constant. Observations were therefore undertaken as opportunity offered with a view to tracing the route followed by *M. melitensis* in the course of the disease as observed in goats, by studying the *post-mortem* localisation in cases of different durations in the light of the information derived from similar observations on the course of the disease in the monkey.

The results obtained, however, are extremely conflicting (*vide* Table X), and the general statement to be formulated immediately, although probably true in the great majority of goat infections, can only be accepted at the present stage of the investigations as a pious opinion or a working hypothesis.

During the early stages of the infection the blood stream and the spleen are the chief seats of *M. melitensis* activity: later the coccus becomes localised to the speen, lymphatic and other glandular structures and kidneys, probably by the operation of a process akin to filtration, but during its existence in the spleen the possibility of its re-appearance in the blood is ever present. Later still those foci present in the kidneys are destroyed, next those in the spleen, then those in the general lymphatic glandular system, so that in infections of long duration the coccus may be absent from all and every organ with the exception of the mammary gland, where it may persist for very extended periods.

In addition to tabulating the observations upon which the opinions enunciated above are based, it will be well to discuss in order the chief organs and tissues from which *M. melitensis* has been isolated.

1. *The Blood.*—Zammit, working with naturally infected goats, noted that "in certain phases of the disease the specific microbe circulated freely in the blood, but that this condition did not last long."* Again, Eyre, whilst using living cultures in the attempt to immunise the goat and the horse, found that living cocci could be isolated from the peripheral blood for about four weeks after an injection.†

* *Vide* these Reports, IV, p. 97.

† Reports, V, pp. 45 and 49.

During the period of incubation, that is to say, between the moment of actual infection and the rapid multiplication of the coccus in the circulating blood, usually some 7 to 21 days, attempts to isolate the coccus from peripheral blood are invariably unsuccessful.

Referring once more to the immunising experiments, it was observed that during the first fortnight after the intravenous injection of living cultures of *M. melitensis* it was a comparatively easy matter to isolate the coccus from peripheral blood, although in gradually decreasing numbers, by simple cultivation methods; by the third week the numbers present were small, and after the fourth week it was not possible to detect the presence of the micrococcus either by cultivation or inoculation experiments.

Then, too, in none of the animals tabulated below was the specific coccus isolated from the heart blood, although one was examined *post mortem* three weeks after infection.

Zammit, however, remarked that some of the goats from whose blood he isolated the micrococcus were undoubtedly cases of long standing, a statement based on a consideration of the physical condition of the goats to which he refers; and the fact that two of them were in poor condition and were passing *M. melitensis* in the milk, lends support to the inference. While it is true that these cases might really have been recent infections, the physical condition and presence of the coccus in the milk being due to the exceptional severity of the infection, this is hardly likely; and the more probable explanation is that in cases of long duration, temporary re-infection of the blood stream sometimes occurs from foci in the spleen—a condition analagous to that observed in man during the course of protracted cases of Malta Fever.

In the majority of cases, therefore, the ready isolation of the coccus from the peripheral blood by cultivation methods would afford strong support to a diagnosis of recent infection.

Spleen.—As will be seen from the synopsis of *post-mortem* findings in Table X, it is quite the rule to isolate the micrococcus from the spleen in cases of short duration and up to about 12 months after infection, at any rate where the infection has been experimentally produced. In animals where the infection has existed for a considerable period (many of the *post-mortems* being carried out on animals which were naturally infected when purchased and had been under observation for periods extending over 12 to 20 months) it is the exception rather than the rule.

Lymphatic Glandular System.—There is as a rule in cases of long duration, as well as the more recent ones, a general enlargement of the lymphatic glands, from all of which the *M. melitensis* can be isolated. In recent infections those glands draining the location of the primary infection contain numerically more of the cocci than those which have

Table X.—Results of *Post-mortem* Examinations of Goats.

No.	Sex.	Remarks.	Duration of infection or period of observation.	Presence of *M. melitensis* noted during life.		Serum value at death.	*Post-mortem* findings. *M. melitensis* present in—					
				Urine.	Milk.		Heart blood.	Spleen.	Kidney.	Glands. Inguinal.	Glands. Mesenteric.	Udder.
			weeks.									
25	♀	Cutaneous inoculation ...	3	–		1 : 100	–	+	–	+	–	0
10	♂	Subcutaneous inoculation	6	–	–	1 : 200	–	+	–	+	–	0
9	♂	,, ,,	6	–	–	1 : 100	–	+	–	+	–	0
5	♀	,, ,,	6			1 : 20	–	+	–	+	+	0
4	♀	,, ,,	6	–	–	1 : 20	–	+	–	–	–	0
Rosso	♀	,, ,,	21	–	–	1 : 1500	–	+	–	–	–	0
XXV	♀	Fed with infected milk...	26	–	–	1 : 100	–	+	–	–	+	0
IV	♀	Fed with emulsion of culture	37	–	At 7 wks.	1 : 20	–	–	–	–	–	–
Bianca	♀	Subcutaneous inoculation	39	–	–	1 : 20	–	+	–	–	–	0
VIII	♀	Fed with infected milk...	41	–	–	1 : 10	–	–	–	–	–	0
XII	♀	Fed with emulsion of culture	42	–	–	?	–	+	–	–	–	0
XIII	♀	Fed with urine infected dust	45	–	At 13 wks.	1 : 10	–	–	–	–	–	0
X	♀	Fed with infected milk...	49	–	At 20 wks.	1 : 20	–	–	–	–	–	+
XI	♀	?	49	–	–	1 : 50	–	–	–	–	–	–

VII	♀	Fed with emulsion of culture	53	–	At 43 wks. to day of death	1 : 100	–	–	–	–	–	0 [illegible]
102	♀	Naturally infected.........	19	–	–	1 : 20	–	–	–	–	+	0
103	♀	" "	19	–	–	1 : 20	–	–	–	–	–	0
118	♀	" "	19	–	–	1 : 10	–	–	–	+	–	0
XIX	♀	" "	43	–	At 20 wks.	1 : 160	–	–	–	–	+	+
III	♀	" "	56	+	+	?	–	–	–	–	–	0
I	♀	" "	60	+	+	?	–	+	+	–	–	0
II	♀	" "	60	+	+	?	–	–	–	–	–	0
V	♀	" "	60	+	+	?	–	–	+	–	–	0
VI	♀	" "	60	+	+	?	–	–	–	+	–	0
XV	♀	" "	60	–	–	?	–	–	+	–	–	0
XVI	♀	" "	60	–	–	?	–	–	–	+	+	0
XVII	♀	" "	60	–	–	?	–	–	–	+	–	0
XVIII	♀	" "	60	–	–	?	–	–	–	–	–	0

– = *M. melitensis* not recovered. + = *M. melitensis* recovered. 0 = not examined.

merely derived their bacterial content from the circulating blood, and in the very early stages (*vide* Goat No. 25) the former glands may alone contain the coccus in demonstrable quantities.

Towards the termination of the infection the lymphatic glands—particularly the inguinal—appear to be the last resting place of the coccus before its final destruction, and in a previous report* this fact has been commented upon by various workers who have expressed the opinion that had the examination of the superficial lymphatic glands in the case of many infections of long standing been neglected, *positive* evidence of infection by the isolation and identification of the *M. melitensis* would have been entirely missed. On the other hand, the evidence available by no means justifies the opinion, also there expressed, that the lymphatic glands were the site of especial reproductive activity on the part of *M. melitensis*. That the glandular infection is not limited to those glands draining the area first infected is well shown in the *post-mortem* results of inoculated monkeys (*vide* pp. 34, 51, and 114) which were examined in the early stages of the disease. In the cases, for instance, of food infection, inguinal and axillary glands as frequently yielded a copious growth of *M. melitensis* as the mesenteric (or bronchial and cervical, although these last are not included in the tables); and in the case of a cutaneous infection (Monkey No. 188) as well as in those of mucous membrane infection (Monkeys No. 200 and 203) when the mesenteric glands gave a growth equal to that from any of the subcutaneous glands.

Kidney.—Although the presence of *M. melitensis* in the tissues of the kidney practically synchronises with the appearance of numerous cocci in the blood stream, the extrusion of the micro-organism in the urine is in the majority of the experimental animals a somewhat late phenomenon. In man, on the other hand, the coccus may be demonstrable in the urine quite early in the acute stages of an attack of Malta Fever. In the rabbit and guinea pig its appearance—although usually late—is fairly constant; in the goat, however, the elimination of the coccus is by no means constant even in cases of very long standing, and it is of interest to record the fact that frequently repeated examinations were made of the urine from all of the infected milch goats, some 20 in number, under observation at the Lazzaretto over a period of about a couple of months without the presence of the coccus ever being detected—although 18 of the animals were eliminating large numbers of the coccus almost daily in the milk. Again, the discharge of the coccus in the urine in cases where it has been observed appears to cease long before its disappearance from the milk.

Mammary Gland.—In the few *post-mortem* observations that were made as to the presence of *M. melitensis* in this situation, it may be

* *Vide* these Reports, IV, p. 69.

noted that the organism was detected distributed throughout the substance of the gland in the case of a goat that had previously yielded the coccus in its milk but had been "dry" for some weeks before it was killed. In three other cases small pieces of the base of the udder, containing the deepest portions of the glandular tissue, were removed. In one (where the coccus had appeared in the milk after the lapse of seven weeks from the date of infection) killed eight months after infection, the coccus could not be recovered from the mammary gland or any other of the organs examined. In another which had never shown *M. melitensis* in the milk during life, and which was killed ten months after experimental infection, the micrococcus was absent from all organs and tissues. In the third, killed 12 months after experimental infection, the coccus was isolated from the mammary gland alone of all the tissues examined.

Where the milk has been systematically examined in animals that have been experimentally infected, the appearance of the coccus in the milk has invariably been a late phenomenon. Goat No. 4, for example, commenced to eliminate the coccus seven weeks after infection, Goat No. 8 three months. Goat No. 7, on the other hand, was infected in September, 1904, and, although repeatedly examined, showed no signs of the coccus in the milk up to January, 1906, when, being "dry," she was impregnated. In July, 1906, she dropped two kids, and three days later the coccus appeared in the milk and was consistently present up to 24th September, when she was slaughtered, and it is interesting to note that in this case the coccus could not be recovered *post mortem* from either spleen, kidneys, or lymphatic glands.

7. *The Transmission of* M. melitensis *Anti-bodies to the Descendants of Infected Goats.*

A further interesting point, and one which has a considerable bearing upon practical preventive measures against the spread of *M. melitensis* infection in the goat, is the fact that while an appreciable amount of specific agglutinin is usually transferred from the infected milch goat to its offspring, the *M. melitensis* itself, minute though it is, does not appear to cross the placenta.* These observations were repeated on several occasions as opportunity offered, and the details concerning four kids born of experimentally-infected mothers (all

* One observation upon the human subject where transference of the micrococcus from the maternal to the fœtal circulation appears to have taken place *in utero* may here be referred to. A pregnant woman (under the care of Captain Williams, R.A.M.C., in the Married Families Hospital, Valletta) gave birth to a male infant during one of the pyrexial periods of an acute attack of Mediterranean Fever. The infant proved to be infected also, the agglutination value of its serum was 1 in 1000—as compared with its mother's 1 in 500—and its temperature curve from birth followed precisely that of the mother, although about half a degree lower, during the subsequent fluctuations.

of which were passing *M. melitensis* in either milk or urine, or both, up to the time of impregnation, and even after), may be tabulated as follows:—

Milch goat.	Kids born.	Serum value in kid.	Kid killed.	*Post-mortem* results *qua M. melitensis.*
1	25.10.05	1 : 50	13.11.05	Nil.
2	2.3.06	1 : 800	4.3.06	Nil.
3	14.7.06	*a* 1 : 50	31.7.06	Nil.
		b 1 : 20	31.7.06	Nil.

Even the small amount of agglutinin present in the serum of the kids of infected goats appeared to be associated with a very definite immunity, for the two kids of Goat No. 3 were fed for 17 days on their mother's milk, and for the last 10 days of this period the milk was teeming with *M. melitensis*, yet, at the *post-mortem* inspection, no trace of *M. melitensis* infection could be detected.

On the other hand, two kids which had been dropped, and subsequently reared by a similarly infected mother, were injected subcutaneously, when they were seven weeks old, with emulsion of cultivation of *M. melitensis*, and were quite unable to resist infection, showing that the resistance offered to invasion by *M. melitensis* can readily be overcome.

8. *The Treatment of Infected Milch Goats with the* M. melitensis *Vaccine.*

The lengthy periods over which apparently healthy milch goats continue to secrete milk of a highly infective character rendered it desirable to inquire into the utility of therapeutic measures in determining the duration of active infection. To this end observations were commenced with regard to the effect of treatment by *M. melitensis* vaccine, as it appeared useless to try any of those drugs that had already proved useless in the treatment of *M. melitensis* infection in the human subject.

Consequently, early in August a batch of vaccine was prepared from a highly virulent strain of *M. melitensis* in the manner described in Section VII, p. 116, and standardised to 1000 million micrococci per cubic centimetre. Seven of the herd of infected milch goats and sheep stabled in the Lazzaretto were selected for the purpose of the experiment—four for treatment, Nos. 104, 111, 114, and 117; and three—105, 107 (sheep), 115—to serve as controls; the milk from all of these animals usually contained *M. melitensis*—often in enormous numbers—as will be seen by reference to Table VII, p. 20. Unfortunately, Goats Nos. 105 and 111 "dried up" shortly after the experiment was started.

The bi- or tri-weekly enumeration of the cocci present in the milk of these seven animals was continued, and observations on the agglutination reaction in serum and milk were also carried out.

Table XI.—*M. melitensis* in Milk of Vaccinated Goats and Controls.

Animal and No.	Goat 104.	Goat 114.	Goat 117.	Controls.	
				Goat 115.	Sheep 107.
Aug. 2 ...	16,000	30,000	24,800	—	1,810
„ 4 ...	—	30,000	—	730	—
„ 7 ...	660	—	—	—	1,000
„ 8 ...	Injected with vaccine (500,000,000 cocci)				
„ 9 ...	1,250	8,300	1,200	3,800	300
„ 11 ...	50	3,000	16,000	3,500	2,500
„ 14 ...	1,600	nil	30,000	8,000	20,000
„ 17 ...	1,500	—	3,400	—	4,200
„ 18 ...	750	6,000	—	—	720
„ 21 ...	1,400	200	2,000	—	1,500
„ 21 ...	Injected with vaccine (1,000,000,000 cocci)			—	—
„ 23 ...	700	5,000	200	1,020	20,000
„ 25 ...	2,000	—	30,000	3,200	30,000
Sept. 4 ...	—	38	525	nil	700
„ 6 ...	110	—	1,161	360	1,600
„ 8 ...	176	—	471	60	2,280
„ 11 ...	127	300	200	560	2,245
„ 15 ...	139	800	*	1,200	3,456
„ 15 ...	Injected with vaccine (1,000,000,000 cocci)			—	—
„ 18 ...	185	*	207	350	4,300
„ 20 ...	*	nil	320	560	5,280
„ 22 ...	nil	*	170	150	*
„ 25 ...	10	20	360	100	*
„ 27 ...	65	15	230	50	5,300

* Plates so contaminated as to be unworkable.

The initial dose of vaccine was 0·5 c.c., equivalent to 500,000,000 cocci, which was injected subcutaneously in the animal's flank. In the course of 12 hours or so the small local swelling caused by the injection had completely disappeared, the animal seemed to be in no way discommoded by the injection, and no marked rise of temperature took place. Within two or three days the agglutination value of both serum and milk fell in a most pronounced fashion, and on one occasion, in the case of Goat No. 114, disappeared altogether from the milk. Four or five days later the dilution in which the agglutination reaction could be obtained had again risen to a higher level than it had occupied previous to the injection of the vaccine—in short, the phenomena observed were exactly comparable to those noted in rabbits and guinea-

pigs under similar conditions.* The numerical strength of *M. melitensis* in the milk at first appeared to be as irregular and as erratic as before the treatment was commenced, but after a second injection of a somewhat larger dose of vaccine (1 c.c., or 1,000,000,000 cocci) 14 days after the first, the numbers underwent a certain diminution. Unfortunately, about this time the milk of another of the controls commenced to dry up, and within a month of the commencement of the experiment only small quantities of milky fluid could be obtained from this animal for examination. The Sheep No. 107, however, continued to yield a good supply of milk containing *M. melitensis* in undiminished numbers. These observations are being continued, for it is obvious that any method of treatment which would cause the destruction of the micrococcus in the infected goats and its disappearance from the milk would be a most valuable weapon in the hands of those who desire to stamp out Malta Fever from our Fleet and garrisons.

In the accompanying table (p. 43), which gives the number of cocci per cubic centimetre in the milk of the treated goats and in the controls, the diminution in the former may be readily followed.

II.—*M. melitensis* Infection by Experimental Feeding with Infective Goats' Milk.

1. *General Considerations.*

The experimental work undertaken by the Commission during the years 1904 and 1905 proved beyond question the possibility of producing a generalised infection in monkeys, goats, and kids as the result of feeding them upon articles of diet artificially contaminated with *M. melitensis,* although many of the earlier experiments were negative, and the value of some of the later positive experiments is depreciated owing to their lengthy duration, which affords opportunity for the introduction of numerous fallacies. For convenience of reference and comparison, these early experiments in the monkey dealing with infection *viâ* the alimentary system, have been tabulated (see pp. 46 and 47).

The method of experimentation that was adopted (*i.e.*, the repeated administration of contaminated food on successive or alternate days, often for long periods of time), combined with the difficulty of demonstrating the presence of *M. melitensis* on every occasion that supposedly contaminated articles of diet were administered, left many points of interest for further investigation.

Perhaps the most important of these was the question whether the administration of one quantum of contaminated food was sufficient to produce an *M. melitensis* infection *viâ* the alimentary tract, for, if so, the equally important question of the duration of the incubation period of the disease would necessarily be further elucidated.

* *Vide* these Reports, V, p. 44.

From the experiments tabulated below, it would at first sight be assumed that enormous doses of the virus are required to produce infection, and that the period of incubation, though varying within very wide limits—from 14 to 76 days—was usually a lengthy one; but a careful consideration of the various factors involved in those experiments is sufficient to show that such an assumption might well be fallacious, for the simple reason that the appearance of specific agglutinins in the blood serum was the criterion adopted as the evidence of infection. Now, it has already been shown elsewhere in these Reports (*vide* Part V, p. 45) that an animal inoculated with an excessively large dose of the micro-organism, or repeatedly injected with dead or with living cultures of *M. melitensis*, either fails altogether to elaborate specific agglutinins, or if such are present at the commencement of the experiment, fails to elaborate fresh supplies, whilst that previously stored in the serum is rapidly destroyed. An obvious explanation of the very lengthy incubation periods would therefore be that many of the animals to which repeated doses of *M. melitensis* were administered in the shape of daily supplies of food infected with the micro-organism, failed to form the specific agglutinins either until very late in the course of the infection, or until the temporary cessation of the "feeding," or the accidental absence of *M. melitensis* from the presumably infected food afforded the necessary respite, and allowed the response to the presence of the micro-organism to emerge from the negative into the positive phase. Again, the experimental inoculation of laboratory animals (*e.g.*, guinea-pigs, and particularly white rats) has shown that death frequently takes place when even a 1 in 10 agglutination reaction is absent and has been absent throughout the course of the infection, while the *post-mortem* examination reveals the fact that all the organs are teeming with the *M. melitensis.*

In support of this view, the case of Monkey No. 2 may be quoted (see Table XII). This animal was—with the exception of one day—fed continuously for 74 days with infective milk, and during this period no agglutination reaction could be obtained with the blood serum. The day following the cessation of the feeding, a very doubtful 1 in 10 reaction was obtained; nine days later the animal suddenly died, and at the *post-mortem* examination *M. melitensis* was recovered from spleen and from glands, although the blood serum still yielded merely an incomplete reaction with a 1 in 10 dilution.

These facts make it a matter of regret that the supply of animals for the early experiments was insufficient to allow of any considerable number being utilised for each experiment. Had it been possible to include more animals in certain of the experiments, so that some might have been killed and examined *post-mortem* during the course of the feeding, it would probably have been found quite frequently that infection had taken place at a very much earlier stage than was indicated by the appearance of the serum reaction.

Table XII.—Feeding Experiments 1904 and 1905.—Monkeys.

No. of experimental monkey.	Duration of "feeding" in days.	No. of "feeds."	Dose of *M. melitensis* at each feed.	Method of administration.	Evidence of infection. Presumptive. Appearance of serum reaction at	Evidence of infection. Presumptive. Value of serum.	Evidence of infection. Absolute. *M. melitensis* recovered from—	Observer.	Reference to volume and page of these Reports.
					days.				
39	32	28	1 agar slope	Culture from human spleen mashed with boiled potato	31	1 : 500	Spleen	H.	I, 50
40	33	28	"		32	1 : 10	Nil	H.	I, 53
113	13	12	?	Naturally infected urine (human) mixed with dust and dried, then sprinkled on food	—	—	Nil	H.	IV, 30
114	55	55	?		—	—	Nil	H. & K.	IV, 31
119	29	22	?		28	1 : 100	All organs	H.	IV, 35
120	29	29	?	Naturally infected urine (human) spread on potato	—	—	Nil	S.	V, 15
121	30	30	?		—	—	*		
26	134	39	?		—	—	*		
122	203	76	?	Naturally infected urine (human) mixed with dust and dried, then mashed up with potato	58	1 : 30	Kidney	S.	V, 16
30	69	63	?		—	—	Nil		
123	80	43	?	... ...	75	1 : 30	All organs		
124	29	29	1 agar slope	Culture from human spleen smeared on potato	13	1 : 30	Superficial glands only	S.	V, 17
125	29	29	"		28	1 : 40	Femoral and axillary glands		

126	29	20	,,	Culture from human urine smeared on potato	17	1 : 80	Nil	S.	V, 18
127	29	29	,,		28	1 : 120	Superficial and mesenteric glands		
2	74	78	?	Mixed milk from infected herd of 11 goats	74 ?	1 : 10	Spleen and glands ...	H. & K.	IV, 58
4	32	78	?		31	1 : 40	,, ...	H. & K.	IV, 56
5	30	70	?		29	1 : 10	,, ...	H. & K.	IV, 54
99	65	31	?	... Variously with mixed milk from infected herd and whole milk from one of three infected goats	65	1 : 10	Mesenteric glands ...	H. & K.	IV, 59
6	24	8	1 agar slope	Culture from goat's milk mashed up with potato	31	1 : 10	All organs..............	H. & K.	IV, 48
7	24	9	,,		35	1 : 50	Spleen and glands ...	H. & K.	IV, 49
8	24	7	,,		25	1 : 10	Axillary, femoral and mesenteric glands	H. & K.	IV, 50
9	24	9	,,		25	1 : 10	Femoral and axillary glands	H. & K.	IV, 51
19A	2	2	,,	... Culture from goat's milk emulsified	33	1 : 10	Spleen and glands ...	H. & K.	IV, 52

* No *post mortem* performed. H. = Horrocks. K. = Kennedy. S. = Shaw.

Basing a working hypothesis upon these considerations, and planning the experiments so that the results might yield the maximum of information, a considerable number of feeding experiments were performed, which for convenience of study are divided into six series. The main object of the experiments was to obtain exact information of the effects, if any, produced by the ingestion of a limited quantity of infective material; therefore it was determined to administer to each animal but one quantum of infected food, then, after a few days' interval, to commence testing the blood for the presence of agglutinins, and thenceforth to continue to apply this test on alternate days; and from the third week onwards to kill and examine *post-mortem* one or more animals each week. These experiments may now be described as follows:—

2. *Feeding with Naturally Infected Milk Artificially Reinforced.*

Series I.—Eight monkeys (*Macacus rhesus*) were employed in this experiment.

From the time of their arrival from Calcutta these animals were kept under observation at the Lazzaretto as to temperature and general condition, and were fed on soft food—boiled rice and boiled potato, together with sugar and water, and the blood serum from each repeatedly examined for *M. melitensis* agglutinins. The general condition being satisfactory, no lesions of the mucous membrane of the mouth, or of the skin of the face, hands, or feet being apparent to visual inspection, and specific agglutinins being absent from the blood, the monkeys were brought over to the laboratory at Valletta and arranged on the roof terraces. Each monkey was fastened in close proximity to a separate wooden cage by means of a chain, rather more than a metre in length, fastened at one end to a staple in the wall, and at the other to a ring in a leathern dog-collar secured around the animal's neck. Each monkey was separated from his neighbour on either side by a wooden partition, some 6 feet in height, projecting at right angles from the wall on which the cage was fastened for about 6 feet, and set in cement at its junction with both wall and pavement. By this means not only was personal contact between a monkey and its neighbour or neighbours rendered impossible, but the chance of contact with food or excrement other than its own was also obviated. In addition to the soft food previously mentioned, each monkey was supplied with about 250 c.c. of sterilised goats' milk per diem for three days. This they readily learned to lap up as they did water. On the fourth day they had the usual morning feed, together with sterilised milk at 8 a.m., but no more food was given that day. The following morning, May 13, 1906, the administration of infected food—goats' milk—took place. The infected milk employed in this

experiment was "mixed milk" derived from a herd of nine goats just received at the Lazzaretto from Rabato, five of which were known to be excreting *M. melitensis* in varying numbers in their milk, while the remainder were suspected of doing so on account of the agglutination reaction yielded by the milk, and the fact that *M. melitensis* had been isolated from the milk before they passed into the Commission's possession, although the micro-organism had not been recovered from the milk during their stay in the Lazzaretto up to the date of the experiment.

Having regard to the fact that any given milch goat shows great variations in the number of *M. melitensis* excreted in the milk even from day to day, a single agar slope culture of *M. melitensis* derived from the milk of Goat No. 104 was emulsified in sterile saline solution, and added to the two gallons of milk obtained from the infected herd. Plate cultivations were then prepared from the milk itself, and from various dilutions thereof, and after incubation at 37° C. for four days the colonies of *M. melitensis* which had developed were enumerated, and it was finally estimated that each cubic centimetre of the infected milk when supplied to the experimental monkeys contained 11,000,000,000 *M. melitensis*. That is to say, on this occasion, the milk contained *M. melitensis* to the number of about 10,000,000,000 per cubic centimetre *before the laboratory culture was added.*

The method of administration of the infective material was quite simple. As the monkeys were accustomed to receive sterilised milk as a regular article of the daily dietary, a small amount, 250 c.c., was supplied to each monkey in a clean pannikin at 9 a.m. From the laboratory window the animals were watched, and it was seen that each lapped up a certain quantity of the milk, in most cases small in amount, or, lifting up the pannikin, drank from it as one would from a cup before turning the receptacle upside down to ascertain whether other more solid food was concealed beneath. At 11.30 a.m. the pannikins were cleaned and a further 250 c.c. supplied to each animal, when the same performance was gone through. Each animal, in all probability, consumed 30 c.c. to 50 c.c. of the milk; certainly no animal ingested as much as 100 c.c. At 2 p.m. the usual feed of boiled rice was given, and from that time forward the ordinary meals were supplied and no more infected material was administered.

To serve as controls two healthy monkeys were each supplied with sterilised goats' milk in similar quantities, and as the two following series were carried out on the same day, they acted as controls for those also.

Six days after the administration of the infected milk a specimen of blood was taken from each monkey and tested for the presence of *M. melitensis* agglutinins. The result in each case was negative. This testing for the serum reaction was repeated thenceforth three or four times every week until the termination of the experiment. On the 10th day after feeding the first agglutination reaction was observed

(1 : 10); on the 12th day three other monkeys gave a good serum reaction in low dilutions (1 : 10, 1 : 20, and 1 : 20), while the first animal gave only an incomplete reaction in 1 : 10. On the 15th day three more monkeys reacted 1 : 10, 1 : 10, and 1 : 80 respectively, and on the 20th day the eighth monkey of the series yielded a 1 : 10 reaction. On this day also Monkeys Nos. 160 and 161 were chloroformed and autopsies performed, and in these, as in all *post-mortems* conducted in the laboratory, a thorough examination was carried out. In addition to the usual naked eye inspection, plate and tube cultivations were invariably established from the spleen, the axillary and inguinal glands, and at least four mesenteric glands; 10 cubic millimetres of blood taken directly from the heart were plated out, and a further supply of blood was collected for the purpose of determining the agglutinating value of the serum at the time of death.

Naked eye inspection of Monkeys Nos. 160 and 161 showed nothing beyond general glandular enlargement, and hypertrophy of the spleen, which was of a dark colour, hard and friable; but as the result of the bacterioscopic examination both these animals were found to harbour *M. melitensis* in the blood and in every organ examined.

Eight days later, that is four weeks from the day of feeding, one of the control monkeys was killed by chloroform and examined, but the result of the autopsy was completely negative. All the organs appeared normal, the blood serum possessed no agglutinating power whatever when tested against *M. melitensis*; nor could *M. melitensis* be demonstrated in any of the organs or tissues examined culturally. The second control was killed on the 36th day, and yielded identical results. Two more animals of this series were killed and autopsies performed on the 32nd day after feeding, the *M. melitensis* being recovered from one or more organs in each case, the spleen invariably yielding a growth of the micro-organism.

The full details of this experiment are tabulated below, while the net result may be summarised by saying that of eight experimental monkeys fed once on somewhat grossly infected milk, eight became infected by *M. melitensis* (as proved by results of *post-mortem* examination) after an incubation period varying from 10 to 20 days (as indicated by the date of appearance of the serum reaction).

Series II.—To contrast with the first series of animals, a further batch of similarly selected monkeys (from the same Indian consignment) were simultaneously prepared for feeding. In substitution for the rice and potatoes in the diet supplied to the animals in Series I, the monkeys in Series II received for the corresponding three days medlars, small Spanish nuts which they cracked between their teeth in order to get at the kernels, and hard roasted peas, the object being to afford the animals every opportunity of abrading the mucous membrane of the buccal cavity, and so facilitating the entrance of

Table XIII.—Feeding Experiments in 1906.—Series I.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction. Day of appearance.	Serum reaction. Amount of dilution.	Duration of experiment in days.	Post-mortem findings. Value of serum.	*M. melitensis* recovered from— 10 c.mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
162	♀	Two meals daily, comprising boiled potatoes, boiled rice, and sterilised milk, May 9, 10, and 11. One similar meal at 8 A.M., May 12.	Not more than 50 c.c. infected goat's milk, containing 11,000,000,000 *M. melitensis* per c.c (Naturally infected goat's milk, reinforced by addition of 1 agar slope culture *M. melitensis*, derived from goat's milk, to 2 gals. of milk.)	Each monkey supplied with 250 c.c. of milk, in an open pannikin, at 9 A.M., and a further 250 c.c. of same milk at 11.30 A.M., May 13, 1906.	10	1 : 10	36	1 : 500	—	—	—	+	+	—	+
159	♂				12	1 : 10	36	1 : 200	—	—	—	—	—	—	+
160	♂				12	1 : 20	20	1 : 100	+	+	+	0	+	+	+
161	♂				12	1 : 20	20	1 : 50	+	+	+	+	+	+	+
163	♂				15	1 : 10	36	1 : 50	—	—	—	—	—	—	+
164	♂				15	1 : 20	36	1 : 200	+	+	+	+	+	+	+
165	♀				15	1 : 10	32	1 : 80	+	+	+	+	+	+	+
23	♀				20	1 : 10	32	1 : 600	+	+	+	+	+	+	+
Controls. 150	♂		About 50 c.c. sterilised goat's milk		—	—	36	—	—	—		—		—	—
172	♀				—	—	28	—	—	—		—		—	—

M. melitensis—converting, in fact, the feeding experiment into a subcutaneous inoculation, and imitating that condition of the mouth which must be frequently present in human subjects resident within the endemic area of Mediterranean Fever—in the anticipation that earlier infection associated with severer constitutional symptoms would sufficiently indicate that the desired end had been attained. Anxiety to ensure the ingestion of the infected food appears, however, to have caused the failure of this portion of the experiment, for the monkeys in Series II received their last lot of nuts and peas on the morning of May 12, and, like the animals in Series I, received no more food until the infected milk was placed before them 24 hours later, by which time any small abrasion caused by cracking nuts would, most probably, have been sealed off from contact with the contents of the mouth by a protective coating of serum.

Of this batch the first monkey gave a serum reaction of 1 : 10 on the 12th day after feeding with infected milk, four reacted for the first time on the 15th day and two more on the 20th day. One cubic centimetre of blood was abstracted from the external saphenous vein (by means of a small serum syringe) of Monkey No. 157 on the 18th day after feeding, and planted into 20 c.c. of broth. After three days' incubation at 37° C. of this first broth reinforcement, plate cultures therefrom yielded a pure culture of *M. melitensis*. Six of the remaining monkeys were killed on the 21st, 32nd, 36th, and 37th days after feeding, and cultural examination of the various organs specified in connection with Series I yielded abundant evidence of generalised infection by *M. melitensis*.

The eighth animal of Series II alone remains to be accounted for. This monkey gave a not quite complete reaction in a dilution of 1 : 10 on the 10th day after feeding; on the 35th day a similar reaction in 1 : 40 dilution.

It was killed by chloroform vapour on June 25, when it gave similar, not absolutely complete, reactions in all dilutions up to 1 : 40. At the autopsy general glandular enlargement of the axillary and inguinal glands was noted, associated with visible distention of the superficial lymphatics. The mesenteric glands were enlarged—some purulent, others caseous, and coverslip film preparations from both varieties, stained by the Ziehl-Neelsen method, showed the presence of acid-fast bacilli morphologically indistinguishable from *B. tuberculosis*. The spleen was large, dark, and friable, and studded all over with miliary tubercles; the lungs, liver, and kidneys appeared normal—the whole making a typical picture of early generalised tuberculosis. Cultivations from heart's blood, spleen, and the usual glands remained sterile up to the end of 10 days, when the period of observation of the cultivations was brought to a close. The most interesting point in this case was, of course, the pseudo-reaction that was obtained with

Table XIV.—Feeding Experiments in 1906.—Series II.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction. Day of appearance.	Serum reaction. Amount of dilution.	Duration of experiment in days.	Post-mortem findings. Value of serum.	*M. melitensis* recovered from— 10 c.mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
151	♀	Two meals daily, May 9, 10 and 11, consisting of peas, medlars, Spanish nuts, and sterilised milk. One similar meal at 8 A.M., May 12.	Not more than 50 c.c. naturally infected "mixed" goat's milk reinforced by addition of 1 agar slope culture of *M. melitensis* (derived from goat's milk) to 2 gallons of milk.	Each monkey supplied with 250 c.c. milk in an open pannikin at 9 A.M., and a further 250 c.c. of same milk at 11.30 A.M., May 13.	12	1 : 10	32	1 : 400	+	+	+	+	+	+	+
153	♂				15	1 : 40	37	1 : 4000	+	+	+	+	+	+	+
155	♂				15	1 : 10	36	1 : 1000	—	+	+	+	+	+	+
157	♂				15	1 : 40	*								
158	♂				15	1 : 10	37	1 : 1000	—	+	+	+	+	+	+
152	♂				20	1 : 10	37	1 : 3000	—	+	+	+	+	+	+
154	♂				20	1 : 40	21	1 : 40	—	+	+	+	+	+	+
156	♀				(15)	(1 : 10)	43	(1 : 40)	—	—	—	—	—	—	—
Controls. 172	♀		About 50 c.c. sterilised goat's milk		—	—	28	—	—	—	—	—	—	—	—
150	♂				—	—	36	—	—	—	—	—	—	—	—

* Still living. *M. melitensis* recovered from peripheral blood on 18th day. Serum reaction on 41st day, 1 : 1000.

the blood serum even up to a dilution of 1 : 40, and at once suggests an explanation of some of the anomalous reactions that are obtained with *M. melitensis* in cases of obscure fever in man.

All the essential details of this experiment (Series II) are tabulated (p. 53), the net result being that of eight experimental animals, one, suffering from *Tabes mesenterica*, was not infected with *M. melitensis*, the remaining seven became infected after an incubation period varying from 12 to 20 days, but presented no especial features as to severity, constitutional symptoms, or of febrile reaction or early appearance of serum reaction that would indicate that infection had taken place by a different path to that traversed in Series I.

This experiment, therefore, although successful in showing the possibility of infection by means of infected food, failed to differentiate between absorption through normal and injured mucous membrane.

Series III.—In a further attempt to investigate the factors involved in the infection through the alimentary system, a third batch of eight monkeys selected for the purpose in a manner similar to that adopted in the two former series were injected subcutaneously, each with 1 c.c. of *B. typhosus* vaccine, a few hours after the morning meal on May 12, with the object of producing a marked constitutional disturbance which should not have passed off by the time the milk infected with *M. melitensis* was administered.

This object was certainly attained—two of the animals in fact succumbed, one being dead on the following morning at 6 a.m., the second dying a few hours after the administration of the infected milk. The remaining six monkeys were clinically distinctly ill, although in no case did the temperature rise above 104° F., repeatedly drank small quantities of the infected milk and refused the rice supplied to them in the afternoon. The following day all were apparently well, and the local swelling marking the seat of injection of the vaccine disappeared completely in the course of a few days.

The results obtained were somewhat conflicting. One animal showed a serum reaction (1 : 10) on the 15th day, and an incomplete reaction (1 : 10) on the 20th day. The agglutinins then disappeared from the blood, and could not again be demonstrated until the 33rd day, when the reaction was obtained in a dilution of 1 : 20. Two more animals reacted on the 20th day, while the sixth, which showed no signs of the presence of agglutinins in the blood, was killed and examined *post-mortem* on the 24th day, after feeding showed absolutely no evidence of *M. melitensis* infection. In two only of the five animals that were infected was *M. melitensis* generalised throughout the body. In the remaining three it was recovered with difficulty—from the spleen alone in two and from the spleen and mesenteric glands in the third.

Despite the danger attending generalisations founded on insufficient premises, it would almost appear that the response of these animals to

the injection of *B. typhosus* vaccine had in some obscure manner enabled the majority of them to make a better fight against the invading *M. melitensis*, and to achieve a more rapid destruction of the organism, than any of their fellows who had not been so stimulated prior to the administration of the infected milk. The details of this experiment are given in the accompanying table (p. 56).

As these three series of feeding experiments were carried out simultaneously and under similar conditions of environment, the same two controls served for all, and the details concerning them will be found tabulated with those of the experimental monkeys in each series.

Having by these experiments shown that the ingestion of a small amount of somewhat heavily infected milk was sufficient to determine a *M. melitensis* infection after an incubation period varying from 10 to 20 days, it now remained to ascertain whether naturally infected milk—without reinforcement by the addition of laboratory cultivation—would suffice to yield a like result, and to this end further sets of experiments were initiated. Before detailing these, however, some comment is necessary on the two possible sources of fallacy which may be urged against the foregoing experiments, viz.:—

(A) Infection conveyed by means of mosquitoes and biting flies.

(B) "Place" infection—by reason of the fact that during the last two and a-half years each and all of the wooden cages had been inhabited at various times by infected monkeys, and were, therefore, possibly more or less contaminated with infective excrement.

Dealing first with (A), it should be noted that during April,* May,† and the early part of June,‡ 1906, an exceptionally cold spell of weather prevailed throughout the island, a few Culex (of the common species, fatigans and pipiens) were observed and caught inside houses, but neither they nor Acartomyia or Stegomyia appeared in the Laboratory or on the terrace until long after many of the experimental animals had given unmistakable evidence of the infection. Flies also were conspicuous by their absence; Stomoxys was not observed upon the terraces during these experiments, and it was not until well on in June that it could be obtained, even from stables, in quantities sufficient for experimental work. These points, however, are by themselves insufficient to absolutely negative the objection raised under heading (A).

In the succeeding experiments further precautions were taken for the express purpose of eliminating the possibility of infection through the

* April, 1906, was the coldest April in the five years 1902—1906, with 26 days in defect of the average for the five-year period.

† May, 1906, was the coldest May in the five years 1902—1906, with 20 days in defect of the average for the five-year period,

‡ June, 1906, was the coldest June in the five years 1902—1906, with 20 days in defect of the average for the five-year period.

Table XV.—Feeding Experiments in 1906.—Series III.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction.		Duration of experiment in days.	Post-mortem findings.							
					Day of appearance.	Amount of dilution.		Value of serum.	*M. melitensis* recovered from— 10 c mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
36	♂	Two meals daily, May 9, 10 and 11, consisting of boiled potatoes, boiled rice and sterilised milk. One similar meal at 8 A.M., May 12.	Not more than 50 c.c. naturally infected "mixed" goat's milk reinforced by the addition of 1 agar slope. Culture of *M. melitensis* (derived from goat's milk) to 2 gallons of milk.	Each monkey supplied with 250 c.c. milk in an open pannikin at 9 A.M., and a further 250 c.c. of same milk at 11.30 A.M., May 13.	10	1 : 20	43	1 : 40	—	—	—	—	—	+	+
171	♀				12	1 : 20	29	1 : 40	+	+	+	+	+	+	+
168	♂				15	1 : 10	43	1 : 20	—	—	—	—	—	—	+
166	♀				20	1 : 10	43	1 : 50	—	—	—	—	—	—	+
170	♂				20	1 : 10	32	1 : 250	+	+	+	+	+	+	+
167	♂				—	—	24	—	—	—	—	—	—	—	—
Controls. 172	♀		About 50 c.c. sterilised milk.		—	—	28	—	—	—	—	—	—	—	—
150	♂				—	—	36	—	—	—	—	—	—	—	—

agency of insects. The animals employed were selected from a consignment of monkeys that arrived in Malta from Calcutta early in July. On their arrival at the Lazzaretto they were placed in mosquito- and fly-proof rooms where they remained until their transference to the Laboratory terraces. Here they were allotted sleeping boxes, each of which was accommodated in a separate cubicle similar to those employed in the first three experiments, but rendered mosquito- and fly-proof by roofing with wood, fronting with a gauze covered framework with hanging door, and caulking all joints and cracks in the woodwork with putty, or pasting them over with stout paper.

With reference to the possibility of infection having taken place through contact with the excrement-polluted woodwork of the sleeping boxes, it may be stated that before allotting a box to a normal monkey, it was first scraped clean; then thoroughly scrubbed inside and out with a 2-per-cent. solution of Lysol, and the wood saturated with the same; then the box was dried in the sun. When thoroughly dry, it was again scrubbed with a fairly strong solution of caustic soda until the wood had regained its pristine whiteness, and no stain or discoloration was visible, well rinsed first with plain water, then with the Lysol solution, and finally exposed to the direct rays of the sun for a day or two.

The cubicle in which the box was to be fitted was thoroughly disinfected by washing down walls and partitions with the Lysol solution (sprayed on by means of a garden squirt), and as the terrace floors are entirely of cement, the same treatment was extended to them.

Finally the two controls and two of the experimental animals failed to contract the disease, and would thus appear to afford proof of the efficacy of the disinfectant measures pursued.

3. *Feeding Experiments with Naturally Infected Milk Alone.*

Series IV.—The same care was observed as in the earlier experiments in picking out animals that were in good general condition, free from cuts and scratches, and from whose blood serum specific agglutinins were absent. The method of preparation for the feeding experiments was identical with that adopted in Series I, and the infective material was again goats' milk derived from the herd of goats under observation at the Lazzaretto. In addition, the monkeys employed in this and the succeeding series had been trained to drink milk from the pannikin "human fashion."

In the fourth set of experiments two monkeys only were employed, and these were each supplied with 500 c.c. of "whole" milk (in two equal quantities as in the previous experiments, the first at 9 A.M., the second at 11 A.M.), the one from Goat No. 114, the other from

Goat No. 115, in order to imitate, as far as possible, the sequence of events taking place in a private household, where the housewife calls to a passing goatherd and receives into the receptacle she provides the milk from one goat for consumption by the family. Each of the goats above-mentioned had been under observation for some months, and was consistently passing *M. melitensis* in its milk. Samples of each of these milks were diluted and plated, and on enumeration after incubation it was found that the milk from Goat No. 114 contained 800 *M. melitensis* per cubic centimetre, and that from Goat No. 115, 300 per cubic centimetre.

The milk was set before the experimental monkeys in pannikins, as in the three former experiments, but, as the animals were shut up in mosquito-proof cubicles, it was difficult to ascertain how much, if any, of the milk had been consumed. With regard to Monkey No. 197, however, it is certain that she ingested at any rate 45 c.c. of the milk from Goat No. 114, as owing to a mistake on the part of an assistant she was anæsthetised during the morning, and a soft rubber catheter passed into her stomach before the error was noticed. Under the circumstances it was deemed advisable to introduce a further dose of the milk she had presumably drunk earlier in the day into her stomach before allowing her to recover from the anæsthetic, and this was accordingly done. Monkey No. 196, on the other hand, only ingested such quantity of milk as she had voluntarily drunk from her pannikin.

Two monkeys which served as "controls" for this and the two following series each received 500 c.c., and consumed about 50 c.c. of sterilised goats' milk.

Of the two animals fed on infected whole milk, Monkey No. 197, which must certainly have received a larger dose of infected milk, and milk moreover which contained at least double the number of cocci per cubic centimetre, showed a definite reaction four days before her fellow sufferer, that is on the 17th day, Monkey No. 196 showing a definite reaction on the 21st day. Exactly one month after feeding, Monkey No. 197 and one of the controls, 189, were chloroformed and careful examinations made of the bodies, with the result that no evidence of infection by *M. melitensis* could be obtained in the case of the control, whilst Monkey No. 197 yielded *M. melitensis* from all the organs examined, although the coccus was absent from the small quantity of heart blood that was plated.

The Monkey No. 196 was chloroformed on the 33rd day, when the blood serum gave an immediate and unmistakable positive reaction in dilutions of 1 in 100. The *post-mortem* examination showed greatly enlarged liver and spleen, each organ being studded with tubercles, many of which were caseous. The superficial lymphatic glands were also enlarged. Cultivations established from the blood and the organs gave rise to a plentiful growth of various bacteria, but no *M. melitensis*

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction. Day of appearance.	Serum reaction. Amount of dilution.	Duration of experiment in days.	Post-mortem findings. Value of serum.	*M. melitensis* recovered from— 10 c. mm. of blood.	Axillary glands. R. L.	Inguinal glands. R. L.	Mesenteric glands.	Spleen.
197	♀	Two meals daily, July 23, 24, and 25, consisting of boiled rice and sterilised milk. One similar meal at 8 A.M. July 26.	Infected "whole" milk (Goat No. 114), 800 *M. melitensis* per c.c.	Each monkey supplied with 250 c.c. of its corresponding milk (see previous column) in open pannikin at 9 A.M., and a further 250 c.c. of milk at 11 A.M. July 27.	17	1 : 10	28	1 : 50	–	+ +	+ +	+	+
196	♀		Infected "whole" milk (Goat No. 115), 300 *M. melitensis* per c.c.		21	1 : 10	33	1 : 100	–	* *	* *	*	*
Controls. 189	♂		Sterilised milk mixed (Goats No. 114 and 115).		–	–	28	–	–	– –	– –	–	–
190	♀				–	–	48	–	–	– –	– –	–	–

* Enlarged and tuberculous.

could be detected or recovered. While in this case there is not a shadow of doubt in the minds of the experimenters that the monkey had been successfully infected, the coexistence of abdominal tuberculosis had exercised such a profound influence on the course of the disease as to render the absolute proof of the existence of infection, viz., the recovery of *M. melitensis* from the various organs *post mortem* impossible to obtain, and this animal must consequently be eliminated from the experiment.

The second control, which was killed on the 48th day, showed no signs *post mortem* of infection with *M. melitensis* and at no period during the course of the experiment could specific agglutinins be detected in its blood serum.

The net result of this experiment, however, is still to conclusively prove that infection may result in the monkey (*e.g.*, No. 197), after the ingestion of one quantum of naturally infected milk, and that not a grossly contaminated sample, with an incubation period of about 17 days.

Series V.—In the next experiment an attempt was made to reproduce the conditions obtaining in the case of a hospital, barracks or other large institution supplied with goats' milk by a contractor who would necessarily command the daily milkings of a large number of goats and who would, for the convenience of all parties, supply "mixed" milk in churns of several gallons capacity.

Experience based upon the examination of the milch goats in a large number of herds from all parts of the island had already shown that a typical herd consisted of something like 60 per cent. normal goats yielding milk free from contamination with *M. melitensis*; 30 per cent. of goats previously infected (and whose milk yields a definite agglutination reaction), but which are either completely convalescent or else are in an early stage of the disease and are consequently not discharging the specific micro-organism in the milk; and 10 per cent. of goats whose milk not only gives a strong agglutination reaction, but also contains *M. melitensis* in varying numbers.

The infective material in this experiment was consequently made up in the following manner:—

Three perfectly healthy goats which gave no evidence of having been infected with *M. melitensis* were milked to the extent of 1 litre each into a sterile bottle.

Goats Nos. 101, 108, 110, whose milk gave a good agglutination reaction, but although plated regularly several times a week for some months had never yet yielded *M. melitensis*, were milked, also in sterile bottles, to the extent of 500 c.c. each. Goat No. 117, whose milk gave a good agglutination reaction and invariably yielded *M. melitensis* when plated, in numbers ranging from a few hundreds to thirty thousand and upwards per cubic centimetre, was milked to the extent of 500 c.c. into another sterile bottle.

Taking 500 c.c. as the unit of measurement, two volumes of milk from each of the three first goats were mixed with one volume from each of Goats Nos. 101, 108, 110 and 117, thus forming a fairly representative "mixed" milk such as would be obtained from an average herd.

Before the mixing was actually carried out, centrifugalised samples or suitable dilutions from the milk of each goat were plated out, and after the usual period of incubation and observation the following results were obtained:—

Goat 117.	Agglutination	reaction	positive.	Contained approximately 1000 *M. melitensis* per c.c.	
" 101.	"	"	"	Contained no *M. melitensis*.	
" 108.	"	"	"	"	"
" 110.	"	"	"	"	"
" 2.	"	"	negative	"	"
" 3.	"	"	"	"	"
" 8.	"	"	"	"	"

Samples of the "mixed" milk plated after mixing gave an average of 100 *M. melitensis* per cubic centimetre.

Two hundred and fifty cubic centimetres of this "mixed" milk were supplied to each of five experimental monkeys at 9 A.M. It was impossible, however, to see what was going on inside the mosquito-proof cubicles and, as much of the milk was wilfully wasted by the animals, a further quantity of 250 c.c. was filled into each monkey's pannikin at 11 A.M. At one o'clock the pannikins were removed, sterilised and refilled with a feed of boiled rice. From this point onwards the ordinary method of feeding was resumed and no more infective material was administered.

Of this batch of five animals, one (191) was found a few days after the feeding to be prostrate and helpless. It refused all food, ran a markedly intermittent temperature, and was found dead on the 10th morning. No serum reaction had been exhibited by this animal during its lifetime, and *post-mortem* examination failed to reveal infection by *M. melitensis*, or indeed any obvious cause for death. This animal must consequently be disregarded and is not included in the table dealing with this experiment.

Of the remainder, Monkey No. 195 first yielded a positive serum reaction (1 : 10) on the 17th day, Monkey No. 194 on the 18th day and Monkey No. 192 on the 21st day. The first Monkey (No. 195) pursued a remarkable course. From the 17th day onwards the dilution in which the serum reaction was obtainable steadily rose until on the 25th day it had reached 1 in 100. At the end of the third week blood was extracted from the external saphenous vein of each of the monkeys comprised in Series IV, V, and VI and planted in broth. Two days later all the tubes were found to be badly contaminated, with the

Table XVII.—Feeding Experiments in 1906.—Series V.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction. Day of appearance.	Serum reaction. Amount of dilution.	Duration of experiment in days.	*Post-mortem* findings. Value of serum.	*M. melitensis* recovered from— 10 c. mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
195	♀	Two meals daily, July 23, 24 and 25, consisting of boiled potatoes, boiled rice and sterilised milk. One similar meal at 8 A.M., July 26.	Not more than 50 c.c. of mixed milk from healthy and infected goats (Nos. 102, 103, 118, 101, 108, 110, and 117) containing 100 *M. melitensis* per c.c.	Each monkey supplied with 250 c.c. milk in an open pannikin at 9 A.M., and a further 250 c.c. at 11 A.M., July 27.	17	1 : 20	38	*	†	–	–	–	–	–	–
194	♀				18	1 : 10	31	1 : 50	+	–	–	–	–	–	+
192	♀				21	1 : 10	33	1 : 100	–	+	+	+	+	+	+
193	♂				—	—	48	—	–	–	–	–	–	–	–
Controls. 189	♂		About 50 c.c. sterilised goat's milk.		—	—	28	—	–	–	–	–	–	–	–
190	♀				—	—	48	—	–	–	–	–	–	–	–

* On the 25th day the serum from this monkey gave a positive reaction with a dilution of 1 in 100.
† On the 21st day the blood from this monkey yielded *M. melitensis* in small numbers.

exception of those planted with blood from Monkey No. 195. These tubes were plated out and yielded a scanty growth of *M. melitensis*. The serum reaction then fell rapidly and on the 32nd day an incomplete reaction was all that could be obtained with 1 : 20 dilution. When killed on the 38th day agglutinins appeared to be absent from the blood serum, as no reaction could be obtained even with 1 : 10 solution. Cultivations from the various organs remained sterile and the non-recovery of *M. melitensis*, *post-mortem*, would appear to indicate that the infection was of a very mild and transitory type.

Another Monkey (No. 193) showed no sign whatever of infection throughout the course of the experiment, no trace even of agglutinin was present in its blood serum up to the date of the termination of the experiment on the 48th day, when it was chloroformed and examined *post-mortem*. *M. melitensis* was not recovered from any of its organs. It is, of course, possible, but not probable, that the monkey refused to take any of the infected milk and the absence of infection may be due to this cause, or to absolute continuity of the mucous membrane of the upper portion of the alimentary tract, but these are pure speculations. The fact remains that this monkey did not become infected by *M. melitensis*.

The two remaining monkeys (Nos. 194 and 192) when killed on the 31st and 33rd days respectively, afforded abundant evidence of generalised infection, so that as the net result of this experiment it may be stated that three out of four monkeys became infected as the result of each ingesting a quantity of mixed milk, containing not more than 5000 *M. melitensis*.

The full details of the results obtained are given in tabular form (p. 62).

Series VI.—As in all the preceding experiments, it may be urged that infection took place not through the intact mucous membrane of the alimentary canal, but through some lesion, perhaps only microscopic in extent, of the mucous membrane of the mouth; in this experiment an attempt was made to differentiate between such and direct absorption through the presumably intact mucous membrane of the stomach and intestinal walls. Two monkeys were, therefore, selected and prepared for the experiment in a manner precisely similar to that adopted in the other experiments; Monkey No. 198 was carefully anæsthetised with an A.C.E. mixture (alcohol, 1 part; chloroform, 3 parts; ether, 6 parts) and when fully unconscious, his mouth gently opened and a wooden gag introduced and fixed behind the canine teeth. The tongue was then pulled forward and a No. 8 soft rubber catheter passed down the œsophagus into the stomach. A small funnel was inserted into the open end of the catheter and 45 c.c. of "whole" milk from Goat No. 117, containing 1000 *M. melitensis* per cubic centimetre poured through into the stomach. Half a minute later the catheter was washed through with 10 c.c. of sterile salt solution, and after another short interval the

Table XVIII.—Feeding Experiments in 1906.—Series VI.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective materials.	Method of adminstration.	Serum reaction. Day of appearance.	Serum reaction. Amount of dilution.	Duration of experiment in days.	*Post-mortem* findings. Value of serum.	*M. melitensis* recovered from— 10 c. mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
198	♂	Two meals daily, July 23, 24, and 25, consisting of boiled potatoes, boiled rice, and sterilised milk. One similar meal at 8 A.M. July 26.	45 c.c. infected milk from Goat No. 117, containing 1000 *M. melitensis* per c.c.	Through soft rubber catheter passed into stomach under an anæsthetic.	—	—	42	—	—	—	—	—	—	—	—
199	♂		45 c.c. infected milk from Goat No. 117, containing 4000 *M. melitensis* per c.c.		—	—	42	—	—	—	—	—	—	—	—
Controls.															
189	♂		About 50 c.c. each of sterilised goat's milk.	*Vide* Table XVII	—	—	28	—	—	—	—	—	—	—	—
190	♀				—	—	48	—	—	—	—	—	—	—	—

open end of the catheter was clipped and the instrument carefully withdrawn. On removing the pressure from the upper end of the catheter nothing but a few drops of clear saline solution flowed from the eye. The animal was kept under the influence of the anæsthetic for a further period of five minutes, then gradually allowed to come to. No regurgitation of milk took place and the monkey was soon sufficiently recovered to be returned to his cubicle. By similar means, Monkey No. 199 had 45 c.c. of whole milk from Goat No. 111, containing 4000 *M. melitensis* per cubic centimetre introduced into his stomach and in this instance also regurgitation of the food was absent.

Of these two animals, Monkey No. 199, which had received some 180,000 *M. melitensis*, showed no signs of the formation of specific agglutinins throughout the entire course of the experiment, and when killed and examined *post-mortem* on the 42nd day the cultivations prepared from the various organs remained sterile. Monkey No. 198, which had received 45,000 *M. militensis*, yielded on the 17th day a very incomplete reaction with 1 in 10 solution of blood serum. A similar incomplete reaction was noted in the same dilution on the 21st and 25th days. No further reaction was obtainable, and when the animal was killed on the 42nd day, the cultivations prepared from the various organs—like those from Monkey No. 199—remained sterile. This experiment therefore yielded completely negative results. In neither case did the introduction of fairly large numbers of *M. melitensis* into the stomach direct—avoiding any contact with the mucous membrane of the upper portion of the alimentary canal—result in the infection of the experimental animal. As the experiments comprised in Series IV, V, and VI were carried out on the same day and under exactly comparable conditions, Monkeys No. 189 and 190 have done duty as controls to all.

The details of this experiment are shown in Table XVIII (p. 64).

4. *Clinical Features of Food Infections in the Monkey.*

On the clinical aspect of the infection produced by these feeding experiments it is unnecessary to dwell at length or to reproduce temperature charts in detail. A few points of interest may, however, be briefly mentioned :—

Temperature.—Speaking generally, the infection, as judged by the course of the animal's temperature and supported by its general appearance and behaviour, appeared to be far from severe during the six or seven weeks some of the animals were under observation, but opinions based upon clinical symptoms were rudely contradicted by the result of the *post-mortem* examinations.

In this connection it is necessary to emphasise the ready response of the temperature of the monkey to environmental conditions. The normal temperature of the Rhesus when confined in the cool, quiet

rooms of the Lazzaretto and attended by a man accustomed to handle such animals and thoroughly acquainted with their habits, averages about 101° F., although such extremes as 99°·2 in the morning and 103°·4 in the evening have been noted. (The temperatures are here given in Fahrenheit degrees for the sake of uniformity with the temperature charts recorded in previous parts of these Reports.) When transferred to the hot, sunny terraces outside the Laboratory—overlooking, perhaps, the noisiest street in Valletta—and handled by a new and ignorant attendant, who at first obviously went in fear of his charges, the normal temperature became probably half a degree higher. When, as sometimes happened, the animal was allowed to resist capture and to struggle for some minutes before it was sufficiently firmly held to allow of its temperature being taken, the resulting reading was sometimes as much as 2° F. too high. Under such conditions as these, febrile temperatures are apt to be fallacious unless very rigorously scrutinised, and to illustrate these irregularities of the temperature curve, the chart of one of the normal healthy controls—Monkey No. 172—may be utilised.

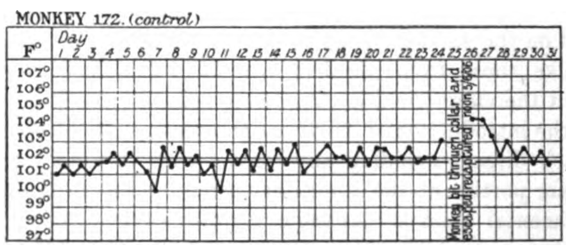


Chart 6.

Another point to be noted with regard to the even temperatures many of the experimental monkeys exhibited, is that, owing no doubt to the strictly enforced cleanliness of the monkeys and their habitations, and the minute attention devoted to the quality of their food, the cases were uncomplicated by diarrhœa and gastro-intestinal disturbances, which are, perhaps, the most fruitful causes of febrile reaction in the monkey.

Again, speaking generally, the temperature chart of the Rhesus infected with *M. melitensis*, except in the case of very severe infections such as follow intercranial injections of the micrococcus, shows but one period of pyrexia, followed by an intermittent temperature of slight range and short duration. A second period of pyrexia, or "wave" as it is colloquially termed, is quite the exception. The remittent type of pyrexia does, however, occur in the monkey; also this animal sometimes exhibits a type of temperature absolutely comparable to the one obtaining in man, when the subject of what Shaw has designated the "ambulatory" type of Mediterranean Fever.

Turning now to concrete examples, the temperature charts of Monkeys Nos. 153, 164, and 155 have been selected to illustrate the three types above referred to, and, although varying so widely in clinical aspect, the severity of the infection must have been of nearly equal intensity in these cases, judging by the results of the bacterioscopic examination, which showed that the blood and all the organs of these animals were literally teeming with the *M. melitensis*.

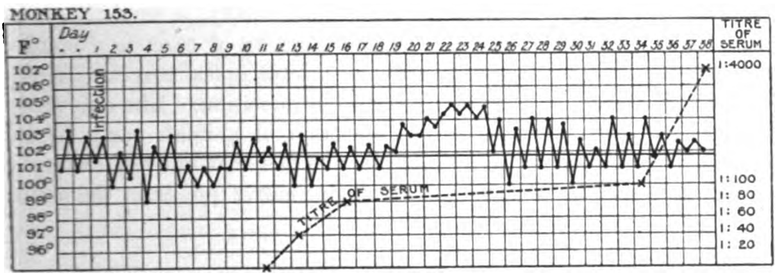


Chart 7.

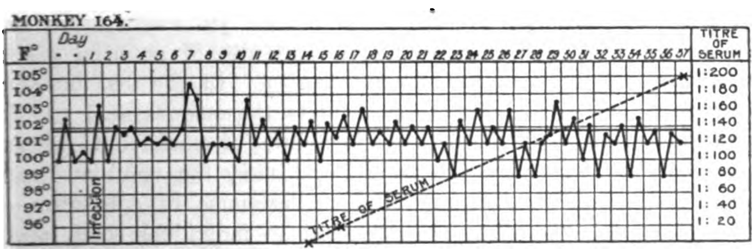


Chart 8.

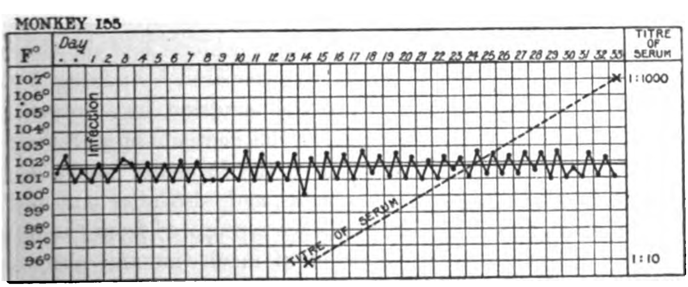


Chart 9.

Agglutination Reaction.—The repeated examinations that were made of blood from each of the infected monkeys showed that for a day or two, or even several days, before a definite reaction was obtainable, a 1 : 10 dilution of the serum produced what is regarded as an "incomplete"

reaction—that is, the micrococci ceased to exhibit active vibratory movement and adhered together in small bunches, but large clumps and masses were not formed and the general field was made up of discrete cocci. Then a good reaction, large clumps in a perfectly clear fluid, readily visible with the two-thirds lens or, indeed, the unaided eye, would be produced by a low dilution of the serum—1 : 10 or 1 : 20. Very often, even at this stage, the macroscopical reaction in the sedimentation tube was absent. Next, the microscopical reaction would often disappear for a day or two, or even longer; finally, it would become firmly established and obtainable in the majority of cases in considerably higher dilutions, and the micro- and macroscopical reactions would control and confirm each other with absolute precision. The exigencies of experiment necessitating the destruction of animals early in the course of the disease are responsible for the fact that but few examples of the development of a very high agglutinative power in the serum were noted.

5. *The Action of Hydrochloric Acid and of Artificial Gastric Juice on* M. melitensis.

During the progress of these experiments, an investigation into the action of hydrochloric acid alone and also of artificial gastric juice upon the *M. melitensis* was undertaken. In the first instance, 1-per-cent. solution of hydrochloric acid to the amount of 5 c.c. was mixed in a sterile test-tube with a like volume of emulsion, in normal saline solution, of cultivation of *M. melitensis*, the emulsion being approximately of the strength of 1 milligramme of cultivation to 100 c.c. of saline solution, or, expressed in individual cocci, about 2,000,000 of *M. melitensis* per cubic centimetre; 5 c.c. of the emulsion mixed with an equal quantity of 0·10 per cent. hydrochloric acid were put up in a second tube, 5 c.c. of the emulsion of *M. melitensis* mixed with an equal quantity of 0·05 per cent. hydrochloric acid solution were put up in a third tube, and a control was prepared by mixing 5 c.c. of normal saline solution with 5 c.c. of the emulsion in a fourth tube. Immediately after mixing, a loopful of the contents of each tube was plated out and the tubes transferred to the incubator at 37° C. At intervals of 5, 10, 15, 20, and 30 minutes, and also after one and two hours' incubation, further similar plates were prepared from the mixture in each tube, and, after the usual period of incubation and observation, each of the plates was carefully studied. Many variations were made in the percentage strength of the hydrochloric acid solution and in the number of cocci per cubic centimetre of the emulsion, and the mixtures were similarly tested. The results obtained were fairly uniform and showed that when the very large numbers of cocci were suspended in weak solution of the acid, very little lethal action was demonstrable.

On the other hand, it will be seen from the experiment tabulated

below, which is a typical one, that *M. melitensis*, when present in an aqueous solution of the acid in moderate numbers only, while able to withstand the lethal action of a 0·025-per-cent. solution of hydrochloric acid as well as of 0·05-per-cent. solution for considerable periods, is destroyed by 0·5-per-cent. solutions within an hour:—

Table XIX.—The Action of HCl upon Watery Suspensions of *M. melitensis.*

Composition of mixture:— Bacterial emulsion and solution of HCl.	Percentage of HCl in mixture.	Time of contact.			
		Immediately.	45 mins.	60 mins.	2 hrs.
5 c.c. + 5 c.c. of 1 per cent.	0·5	+	±	—	—
5 c.c. + 5 c.c. of 0·1 per cent.	0·05	+	+	+	±
5 c.c. + 5 c.c. of 0·05 per cent.......	0·025	+	+	+	+
Control.					
5 c.c. emulsion of cocci + 5 c.c. of saline solution	—	+	+	+	+

+ = Good growth, ± = Scanty growth, — = No growth.

Next, a couple of sterile flasks were taken and 25 c.c. of milk from Goat No. 115, containing some 2500 *M. melitensis* per cubic centimetre, was introduced into the interior of one, and 25 c.c. of artificial gastric juice added and thoroughly mixed. The composition of the artificial gastric juice was:—

Pepsin	0·32 gramme
Hydrochloric acid..................	0·02 ,,
Sodium chloride	0·22 ,,
Sterile distilled water	100 c.c.

A control was formed by mixing 25 c.c. of milk from Goat No. 115 and sterile saline solution.

After plating a loopful from each mixture to determine the number of micrococci present at the commencement of the experiment, the flasks were placed in the incubator at 37° C. At 15, 30, 60 minutes, 2 and 24 hours, the flasks were removed from the incubator and about one-tenth of a cubic centimetre from the contents of each plated out, and after incubation the colonies of *M. melitensis* which developed were enumerated.

One of the experiments—a representative one—is tabulated below, and shows that the artificial gastric juice exerts some, although slight, inhibitory action on the growth of *M. melitensis* from the moment of contact.

Table XX.—The Action of Artificial Gastric Juice upon *M. melitensis* present in Naturally Infected Milk.

Mixture.	Time of contact.				
	Immediately.	15 mins.	30 mins.	60 mins.	2 hrs.
25 c.c. artificial gastric juice + 25 c.c. milk from Goat No. 115	420	640	130	250	440
Control.					
25 c.c. normal saline solution + 25 c.c. milk from Goat No. 115	1390	850	2700	1890	3050

The numbers give the calculated yield of *M. melitensis* per cubic centimetre.

III.—*M. melitensis* Infection following the Ingestion of Infective Milk in Man.

As an interesting and highly instructive corollary to the foregoing infections in the monkey, resulting from experimental feeding with infective milk, the occurrence of an epidemic of Malta Fever on board the s.s. "Joshua Nicholson," a cargo steamer, which conveyed a herd of milch goats from Malta to Antwerp towards the end of the summer of 1905, may be cited. Many of the officers and crew partook of the milk of these goats, and subsequent bacteriological investigations proved that some of these animals were infected by *M. melitensis*. As a result of the investigations made at the end of 1905 and during 1906, there can be no reasonable doubt that the cases of Malta Fever reported from the ship were due to the ingestion of the infected milk.

The history of the outbreak has been carefully compiled by Staff-Surgeon Clayton, and full epidemiological details, together with the history of each individual case so far as can be ascertained, is presented in a succeeding Part of these Reports, but because the history, read in the light of the results recorded in the previous section, savours so strongly of a carefully planned laboratory experiment, a short *résumé* is inserted here.

Résumé of the Outbreak of Mediterranean Fever on Board the s.s. "Joshua Nicholson."

1. *History of the Goats.*

Mr. Thompson, of the United States Bureau of Animal Industry, visited Malta in the summer of 1905, and during a stay of some

months gradually purchased a herd of 61 milch goats (all healthy in appearance and good milkers, many being prize animals), and four billy goats. These he shipped on board the cargo steamer "Joshua Nicholson," on August 19, 1905, for passage to the United States *viâ* Antwerp. During the voyage, which lasted until September 2, 1906, when Antwerp was reached, the goats were milking well, and many of the ship's company partook freely of the milk—the officers drinking "mixed" milk collected in a large vessel, the members of the crew each obtaining "whole" milk from one goat in his own separate pannikin.

On arrival at Antwerp the goats were at once transferred to the quarantine station, where they remained for the five days that elapsed before they were re-embarked on the s.s. "St. Andrew" bound for New York, and during this voyage a large quantity of milk was again available for consumption. New York was reached about September 24, and the animals were transferred to the quarantine station at Athenia, N.J., where they remained under observation. Subsequent bacteriological examination resulted in the recovery of *M. melitensis* first from the milk of two of the goats and afterwards from that of several more.

2. *The Incidence of Mediterranean Fever among those who partook of the Milk.*

(a) *In the s.s. "Joshua Nicholson."*—In addition to four passengers (Mr. Thompson and three goatherds) present on the voyage from Malta to Antwerp, the "Joshua Nicholson" carried 23 officers and men. Of the crew of 19, the carpenter, boatswain, and mess-room steward, together with eight others (11 in all), left the ship at Antwerp; the boatswain was afterwards in hospital suffering from hernia; the movements of the remainder cannot be traced. Of the 12 remaining officers and crew, eight fell sick at intervals varying from 18 to 34 days from the embarkation of the goats, and in the cases of five of these eight the blood reactions leave no room for doubt that Mediterranean Fever was the cause of their illness.

The four members of the ship's strength who did not show any signs of illness were the second mate and the cabin boy, with whom the milk disagreed and who consequently had but very little, and two engineers (Germans) who drank the milk, it is true, but appear to have always boiled it.

Of the three goatherds, one (the chief goatherd) had undoubtedly been infected with *M. melitensis* previous to July, 1906, as evidenced by the presence of specific agglutinins in his blood, but whether recently or remotely it was impossible to say: about the two assistant goatherds no information could be obtained.

(b) *At Antwerp.*—The staff of the quarantine station and many

individuals in the neigbourhood are said to have partaken of the milk, both raw and boiled, during the five days the goats were interned here, but no information can be obtained of the subsequent occurrence of cases of illness resembling Mediterranean Fever.

(c) *In the s.s. "St. Andrew."*—The s.s. "St. Andrew" carried 30 cattle men and the three goatherds and Mr. Thompson, in addition to a crew of 30 men. Most of these drank of the milk, but the master of the ship and also his owners state that none of the men suffered from any illness.

(d) *In America.*—With the exception of Mr. Thompson, who died in January, 1906, from "bilateral pneumonia following influenza," and about whose medical history, *quâ* Mediterranean Fever, no evidence can be obtained, only one person—a woman at the quarantine station—took the milk in any quantity. She, however, drank the mixed milk from several goats for a considerable period, and in December, 1905, suffered from a typical attack of Mediterranean Fever.

3. *The Results.*

In summarising the result of this unpremeditated experiment, several factors have to be considered. For instance, a certain unknown number of goats—more, however, than two—were shown to be secreting infective milk after their arrival in America, some three months after leaving Malta, but there is no direct evidence as to the number whose milk contained *M. melitensis* during the voyage, in summer weather, from Malta to Antwerp. Arguing from analogy with average Maltese herds, at least six should have been secreting infective milk. The goats purchased by Mr. Thompson were, however, picked animals and heavy milkers, and as experience has shown that the goats yielding the most milk in any given herd are the most likely to be passing *M. melitensis* in their milk, the probability is that in this particular herd of 60 milch goats (one having died the day after leaving Malta) the milk from considerably more than six was heavily infected—an inference which receives confirmation from the fact that the three officers and the steward who drank "mixed" milk each developed an attack of Mediterranean Fever, the remaining officer and the cabin boy, with whom the milk disagreed and who consequently did not drink it, remained well.

The members of the crew, on the other hand, each drank "whole" milk from a single goat, and apart from the possibilities of the milk being supplied on any particular occasion from an uninfected animal, a reference to Section I (3), shows clearly the possibilities of a man who obtains milk, even from an infected animal, avoiding the ingestion of *infective* milk.

Apart from such considerations, however, it suffices to state the net result as follows:—

Of 23* men on board the s.s. "Joshua Nicholson" who drank on one or more occasions presumably infected milk, no evidence whatever is available as to 12 and no relevant information as to Mr. Thompson; of the remaining 10, one suffered from hernia only, one was infected by *M. melitensis* at an unknown date, while eight suffered from febrile attacks—5 (or 50 per cent. of them) yielding conclusive evidence of infection by *M. melitensis.*

IV.—The *Rôle* of the Mosquito and other Blood-sucking Insects in the Dissemination of *M. melitensis.*

That the mosquito may act as the vehicle in the conveyance of the infection of Mediterranean Fever may be an example of the wish being father to the thought, and due in part to the inconvenience caused to residents in Malta by these little pests. The rise in the case-incidence curve of the disease in June, July, August and September,† roughly corresponding as it does to the mosquito season, gives colour to a suggestion which is by no means new. In 1902 Zammit produced detailed evidence of an epidemiological character in support of the mosquito theory—that is to say before this observer had noted the natural infection of goats—later on Zammit, Horrocks and Kennedy produced experimental evidence of similar tendency, and more recently still Ross has laboured the point on purely theoretical grounds.

Before, however, attacking the question of the conveyance of *M. melitensis* infection, it became necessary to study the species of mosquitoes prevalent in Malta, since it seemed possible, arguing from analogy, that some one particular species, and one only, acted as the vehicle.

1. *Species of Mosquitoes occurring in Malta.*

Six species, representing five genera and two sub-families, are of common occurrence, viz. :—

Culex fatigans	Sub-family Culicina.
Culex pipiens	
Theobaldia spathipalpis......	
Acartomyia Zammitii	
Stegomyia fasciata	
Anopheles maculipennis......	Sub-family Anophelina.

and apart from Anopheles, which is restricted at present, so far as breeding place is concerned, to one valley in the centre of the island,

* That is disregarding the two men who boiled the milk before drinking it, and the officer and cabin boy who did not drink the milk.

† Johnstone, these Reports, II, p. 36.

Table XXI.—Synopsis of the Characters of the Maltese Mosquitoes.

	I and II. *Culex fatigans* and *C. pipiens.*	III. *Theobaldia spathipalpis.*	IV. *Acartomyia Zammitii.*	V. *Stegomyia fasciata.*	VI. *Anopheles maculipennis.*
Distribution	Over the entire island. Essentially a domestic mosquito.	As I and II.	Round the entire coast-line. On first appearance is found also in houses in urban districts.	As I and II.	Restricted to the Wied Ta Klighi, a deep valley between the Imtarfa and Klighi Hills.
Breeding places	Shallow stagnant pools; agricultural water-tanks; any small collections of stagnant water in artificial receptacles, such as flower-pots and saucers, buckets, old tins, etc., near to human habitations.	As I and II. Also in slowly flowing watercourses in rural districts.	In the salt pans on the rocky coast. In salt-water pools along the shores of the harbours.	As I and II. Often found in the same collection of water.	In the watercourse occupying the bed of the ravine from Fiddian Bridge to the artificial dam.
Time of appearance	Found all through the year.	As I and II.	April to October.	June or July to September.	May or June to September.
Most plentiful	From May to July onward to September.	May to August.	After October the heavy seas produced by the Grigali wind cause the disappearance of this mosquito.	July and August.	After September the watercourse is full and swiftly running.
Ovum—					
Length	0·7 to 0·9 mm.	1 mm.	0·5 mm.	0·4 to 0·6 mm.	0·7 mm.
Shape	Oblong, slightly curved; one end rounded, the other somewhat pointed.	As I and II.	Pointed oval.	Ovoid, more pointed at one end than other. Surrounded by a series of small air-chambers, which give a reticulated appearance to surface.	Elliptical.
Colour	White when first laid, rapidly turning grey, brown, and finally black.	As I and II.	White when first laid, rapidly becoming dark brown and black.	As I and II.	White, rapidly turning to greyish black.
How deposited	In masses or rafts irregularly quadrilateral, or elongated spindle-shaped; 5—8 mm. long × 3—4 mm. broad. Upper surface of raft slightly concave, as eggs, which cohere by sticky lateral surfaces, are arranged pointed ends upwards.	Rafts larger than I and II; pointed oval or boat-shaped, 10—15 mm. long by 5—8 mm. at broadest point.	Usually in rows, side by side, like a palisade, rarely singly or in pairs.	Singly and in pairs, side by side.	Singly, but float close to each other, and often cohere by their ends and form triangular patterns.
Number	200—400.	100—200.	25—100.	40—150.	40—100.
When deposited	Soon after sunrise, and also at dusk.	As I and II.	As I and II.	As I and II. Also at mid-day.	As I and II.
Period of incubation	24—72 hours. The larvæ escape through the thin rounded lower ends of ova.	As I and II.	As I and II.	48 hours to 3 days.	As I and II.
Larva—					

Colour	Pale grey or straw coloured with greenish tinge, or deep dirty brown.	Pale greenish to greenish brown.	Grey to light brown.	Greyish white.	Yellowish green to green or black, with mesial dorsal dark stripe.
Head	Large, with very prominent dark eyes.	Bright chestnut-brown, with black eyes, and band across nape.	Quadrangular, prominent oval eyes.	Large and quadrangular, smaller than thorax.	Small, oval in shape, with many black spots.
Thorax	Larger than head.	Wider than head.	Larger than head; three tufts of bristles on either side.	—	Broader than head.
Abdomen	Nine segments, four anal fins at apex of ninth.	—	All nine segments nearly the same width. Segments 1 to 8 bear lateral tufts of long bristles. Segment 9 bears four anal papillæ at apex and ventral tufts of bristles arranged fanwise.	All nine segments nearly the same width. Anal fins short, bluntly finger-shaped.	Nine segments progressively decrease in width, but increase in length. Segments 1 to 3 bear long lateral bristles, which balance larva horizontal to surface film. Joint 9 bears swimming fan formed of long feathered bristles. Segment 9 carries four anal papillæ only.
Respiratory tube	Long, rising from eighth segment.	Short and thick.	Long, rising from 8th segment.	Short, broad, barrel shaped, and black in colour.	Two simple spiracles only on 8th segment.
Position when breathing	Hangs obliquely or vertically, head downwards, top of siphon at surface film.	As I and II.	Obliquely, head downwards or horizontally just below surface film.	At small angle to surface film, or horizontal. Remains at bottom of water for long periods.	Horizontal immediately below the surface film.
Duration of larval stage	Moults three or four times during a period of 14—21 days.	As I and II.	11—15 days.	8—12 days.	16—21 days.
PUPA—					
Size	6 to 8 mm.	8 to 10 mm.	5—6 mm.	7 mm.	7 mm.
Colour	Dirty brown.	Dirty brown.	Dark brown.	Deep brown.	Yellowish green to grass-green, or dull brown.
Head and thorax	Fused.				
Eyes	Large, oval, prominent.	—	Oval and prominent.		
Respiratory horns	Two trumpet-shaped, narrow bases, oblique openings rise from dorsum of thorax.	Curved with truncated ends.	Curved, funicular, narrow bases, oblique openings.	Large, broadly cylindrical, obliquely truncated at apex, narrowed at base.	Short with square truncated ends.
Abdomen	Nine segments, flattened dorso-ventrally. 8th segment carries pair of oval fins, supported on hard mid-rib. 9th segment carries blunt process on either side of anus.	1st segment, tree-like tuft of bristles on dorsum. 9th segment, prominent anal fins.	As I and II.	1st segment, tuft of bristles. Two broad anal fins with long central rod.	Segments 4 to 8, black spot on either side.
Duration of pupal stage	Imago emerges in from 2 to 4 days.	As I and II.	1—3 days.	2—3 days.	5—10 days.

Table XXI.—Synopsis of the Characters of the Maltese Mosquitoes.

	I and II. *Culex fatigans* and *C. pipiens*.	III. *Theobaldia spathipalpis*.	IV. *Acartomyia Zammitii*.	V. *Stegomyia fasciata*.	VI. *Anopheles maculipennis*.
Distribution	Over the entire island. Essentially a domestic mosquito.	As I and II.	Round the entire coast-line. On first appearance is found also in houses in urban districts.	As I and II.	Restricted to the Wied Ta Klighi, a deep valley between the Imtarfa and Klighi Hills.
Breeding places	Shallow stagnant pools; agricultural water-tanks; any small collections of stagnant water in artificial receptacles, such as flower-pots and saucers, buckets, old tins, etc., near to human habitations.	As I and II. Also in slowly flowing watercourses in rural districts.	In the salt pans on the rocky coast. In salt-water pools along the shores of the harbours.	As I and II. Often found in the same collection of water.	In the watercourse occupying the bed of the ravine from Fiddian Bridge to the artificial dam.
Time of appearance	Found all through the year.	As I and II.	April to October.	June or July to September.	May or June to September.
Most plentiful	From May to July onward to September.	May to August.	After October the heavy seas produced by the Grigall wind cause the disappearance of this mosquito.	July and August.	After September the watercourse is full and swiftly running.
OVUM—					
Length	0·7 to 0·9 mm.	1 mm.	0·5 mm.	0·4 to 0·6 mm.	0·7 mm.
Shape	Oblong, slightly curved; one end rounded, the other somewhat pointed.	As I and II.	Pointed oval.	Ovoid, more pointed at one end than other. Surrounded by a series of small air-chambers, which give a reticulated appearance to surface.	Elliptical.
Colour	White when first laid, rapidly turning grey, brown, and finally black.	As I and II.	White when first laid, rapidly becoming dark brown and black.	As I and II.	White, rapidly turning to greyish black.
How deposited	In masses or rafts irregularly quadrilateral, or elongated spindle-shaped; 5—8 mm. long × 3—4 mm. broad. Upper surface of raft slightly concave, as eggs, which cohere by sticky lateral surfaces, are arranged pointed ends upwards.	Rafts larger than I and II; pointed oval or boat-shaped, 10—15 mm. long by 5—8 mm. at broadest point.	Usually in rows, side by side, like a palisade, rarely singly or in pairs.	Singly and in pairs, side by side.	Singly, but float close to each other, and often cohere by their ends and form triangular patterns.
Number	200—400.	100—200.	25—100.	40—150.	40—100.
When deposited	Soon after sunrise, and also at dusk.	As I and II.	As I and II.	As I and II. Also at mid-day.	As I and II.
Period of incubation	24—72 hours. The larvæ escape through the thin rounded lower ends of ova.	As I and II.	As I and II.	48 hours to 3 days.	As I and II.
LARVA—					
Size of adult	4 mm. long.	10 mm. to 12 or 14 mm. long.	5 mm. long.	6 mm. long.	5—7 mm. long.

Colour	Pale grey or straw-coloured with greenish tinge, or deep dirty brown.	Pale greenish to greenish brown.	Grey to light brown.	Greyish white.	Yellowish green to green or black, with mesial dorsal dark stripe.
Head	Large, with very prominent dark eyes.	Bright chestnut-brown, with black eyes, and band across nape.	Quadrangular, prominent oval eyes.	Large and quadrangular, smaller than thorax.	Small, oval in shape, with many black spots.
Thorax	Larger than head.	Wider than head.	Larger than head; three tufts of bristles on either side.	—	Broader than head.
Abdomen	Nine segments, four anal fins at apex of ninth.	—	All nine segments nearly the same width. Segments 1 to 8 bear lateral tufts of long bristles. Segment 9 bears four anal papillæ at apex and ventral tufts of bristles arranged fanwise.	All nine segments nearly the same width. Anal fins short, bluntly finger-shaped.	Nine segments progressively decrease in width, but increase in length. Segments 1 to 3 bear long lateral bristles, which balance larva horizontal to surface film. Joint 9 bears swimming fan formed of long feathered bristles. Segment 9 carries four anal papillæ only.
Respiratory tube	Long, rising from eighth segment.	Short and thick.	Long, rising from 8th segment.	Short, broad, barrel shaped, and black in colour.	Two simple spiracles only on 8th segment.
Position when breathing	Hangs obliquely or vertically, head downwards, top of siphon at surface film.	As I and II.	Obliquely, head downwards or horizontally just below surface film.	At small angle to surface film, or horizontal. Remains at bottom of water for long periods.	Horizontal immediately below the surface film.
Duration of larval stage	Moults three or four times during a period of 14—21 days.	As I and II.	11—15 days.	8—12 days.	16—21 days.
PUPA—					
Size	6 to 8 mm.	8 to 10 mm.	5—6 mm.	7 mm.	7 mm.
Colour	Dirty brown.	Dirty brown.	Dark brown.	Deep brown.	Yellowish green to grass-green, or dull brown.
Head and thorax	Fused.				
Eyes	Large, oval, prominent.	—	Oval and prominent.		
Respiratory horns	Two trumpet-shaped, narrow bases, oblique openings rise from dorsum of thorax.	Curved with truncated ends.	Curved, funicular, narrow bases, oblique openings.	Large, broadly cylindrical, obliquely truncated at apex, narrowed at base.	Short with square truncated ends.
Abdomen	Nine segments, flattened dorso-ventrally. 8th segment carries pair of oval fins, supported on hard mid-rib. 9th segment carries blunt process on either side of anus.	1st segment, tree-like tuft of bristles on dorsum. 9th segment, prominent anal fins.	As I and II.	1st segment, tuft of bristles. Two broad anal fins with long central rod.	Segments 4 to 8, black spot on either side.
Duration of pupal stage	Imago emerges in from 2 to 4 days.	As I and II.	1—3 days.	2—3 days.	5—10 days.

Table XXI—*continued.*

	I and II. *Culex fatigans* and *C. pipiens.*	III. *Theobaldia spathipalpis.*	IV. *Acartomyia Zammitii.*	V. *Stegomyia fasciata.*	VI. *Anopheles maculipennis.*
IMAGO—					
Size	♀ 4·5 to 5·5 mm.; ♂ slightly smaller, 4—5 mm.	9—11 mm.	4—4·5 mm.	3—5 mm.	5—7 mm.
Head	Brown, covered with pale golden brown curved scales, with scattered dark brown upright forked scales.	Almost black, with two median curved lines uniting in front and behind as a white line between the eyes.	Ochraceous yellow at the sides. White in the middle.	Dark brown or black, with white patch in the middle and white patch on either side.	Black, with two patches of creamy scales, divided by a central line.
Thorax	Brown, with curved scales; two parallel dark lines and three rows of black bristles. Ornamentation very variable.	Umber brown with white lines and spots.	Brown with yellowish and creamy curved scales.	Dark reddish brown, with two median parallel pale lines and a curved silvery line on each side.	Brown, bluish gray in centre, deep brown at sides.
Abdomen, dorsum	Dark brown scales, with flaxen basal bands, broader laterally to form spots.	Yellow scales with scattered black scales.	Blackish brown with basal white bands.	Black, with white basal bands and lateral spots.	Dark brown, with tawny brown markings and dark apical bands.
„ venter	Pale yellow scaled.	Pale flaxen scales with few scattered dark ones.	All creamy.		
Legs	Dark brown and unbanded; bases of coxæ and femora pale; knee-spot white or yellow; tarsi dark brown; ungues, ♀ equal and simple, ♂ fore and mid unequal and toothed, hind equal and simple.	Coxæ yellowish with white scales. femora pale at base with ragged yellowish band before apex; tibiæ striped black and white; metatarsus black with white basal band; tarsi black; ungues equal and simple.	Brown apical and basal pale bands. The last hind tarsal white. Ungues equal and simple.	Black with basal white bands. Last segment of hind legs pure white. Fore and mid ungues toothed; hind untoothed.	Unbanded, brown. Small pale knee-spot, tarsi dark brown, ungues equal and simple.
Wings	1st sub-marginal cell longer and narrower than 2nd posterior cell. *C. fatigans*, ratio stem to cell = 1 : 4. *C. pipiens* „ „ = 1 : 7.	Curved, with long brown scales aggregated to form three distinct dark spots, one where the 2nd long vein rises from the 1st, one at the anterior and mid cross veins, and one at the fork of the 5th long vein.	Mottled brown and grey scales.	Veins clothed with long, narrow, brown scales.	Covered with narrow black scales aggregated to form four spots, one at the base of the first fork cell, one at the second fork cell, one at the cross veins, and one at the base of the second long vein.

[I am much indebted to Mr. F. V. Theobald, F.E.S., for his kindness in reading through the proof of this table, and supplying data for some of the then blank spaces.—JNO. EYRE.]

and Acartomyia, which breeds along the coast line, these species are fairly uniformly distributed over the entire island.

The accompanying synoptical table, adapted from Theobald in accordance with observations made in Malta during the summer of 1906, details the chief points of similarity and distinction between the various mosquitoes, and is introduced here in the hope that it may prove helpful to workers in Malta in this or similar fields.

2. *Supply of Mosquitoes and Notes on their Habits in Captivity.*

The supply of insects required for the experimental work in connection with the attempts to transmit *M. melitensis* infection by the aid of mosquitoes was kept up by repeatedly collecting large quantities of larvæ and pupæ, transferring them to shallow glass dishes of water and allowing them there to complete their development—each species being confined in a separate gauze covered breeding-cage provided with two soft gauze sleeves (of sufficient capacity to admit the hand and arm), situated in the front of the cage and so permitting ready access to any part of the interior. To facilitate the entry of the hand, the free extremity of the long sleeve was attached to a circle of

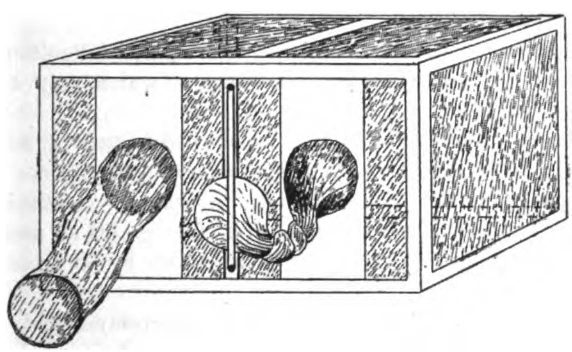


Fig. 3.—Mosquito Breeding Cage.

wire. By twisting the sleeve upon itself and pushing the wire circle under a tightly stretched piece of elastic (attached to the front of the cage) the imagines were effectually prevented from escaping (fig. 3). With adequate care, in such a cage the mortality of imagines when they emerged from their pupa cases was by no means excessive, and after being fed on blood the impregnated females readily laid their eggs in the water in which they had passed the early stages of their existence.

The morning of the day preceding a feeding experiment the perfect females were captured in detail and each transferred to a short length of glass tubing (4 to 6 cm. long by 1·5 cm. in diameter) covered at

one end with a piece of muslin secured by an indiarubber band and closed at the other by a well-fitting cork, where they remained, without food, for from 30 to 32 hours. This useful little piece of apparatus (fig. 4) enabled a distinguishing number or letter to be assigned to every mosquito, simplified the handling of the insects, and rendered it an easy matter to ascertain that feeding had actually taken place, and indeed to watch the entire progress of the act.

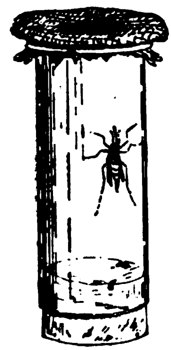


Fig. 4.—Experimental Feeding-tube for Mosquitoes.

In connection with these experiments many difficulties, varying with the species, were encountered, some of which may be usefully referred to.

In the first place, cannibalism is a marked feature of mosquito life during the larval stage, of all the species, and probably not more than 50 per cent. of the larvæ—under laboratory conditions—attain maturity. The occasional addition of a few grains of tapioca to the water containing the larvæ certainly reduces, but by no means prevents, this wastage.

Then it was soon found that female Acartomyia and sometimes *Culex* (*fatigans* and *pipiens*) when segregrated immediately after emerging from the pupa were weakly, could not under any conditions be induced to bite, and soon died. This reluctance of the virgin to suck blood has frequently been noted, and it was consequently found necessary to allow the females to remain in company with the males for two or three days after emerging from the pupa in order to ensure an adequate supply of impregnated females, the insects being freely supplied with fruit—chiefly apples—and syrup during this period. By adopting this method the weakly imagines, which quickly died, were weeded out and a supply of sturdy females was insured.

Again, Acartomyia, although naturally a voracious feeder during the daytime as well as after dusk, like Culex could not in captivity be induced to bite until after dusk and occasionally until after night was

well advanced. Captive Stegomyia, on the other hand, bit readily at any time during the 24 hours.

In feeding mosquitoes a large fund of patience is required. Some, particularly Stegomyia, will go down as soon as applied to the skin and commence feeding at once; others, like Acartomyia, are a considerable time testing area after area of skin with the proboscis before a suitable spot is found and the actual abstraction of blood begins. Individuals again may have to be coaxed before they will begin operations by shading the tube in which they are confined from the direct light, or by raising its internal temperature by closely encircling it with the hand.

Having commenced to feed, the time taken by various individuals to completely fill themselves varies largely and bears no direct relationship to the size of the insect. A presumably thirsty Stegomyia will sometimes fill itself inside 30 seconds, another of apparently equal capacity, or the same individual on another occasion will require some 15 minutes to reach the stage of repletion: Acartomyia usually requires from one minute to five minutes to complete the meal. The shortest time noted was achieved by one of the largest Stegomyia in our possession, which required only 15 seconds to appease its appetite.

The quantity of blood taken up by the insect at one feed is also a matter of some importance, for the minimal quantity of blood from Malta Fever patients in which Gilmour and Shaw* were able to demonstrate the presence of *M. melitensis* was approximately 3 and 4 cubic millimetres respectively. The micrococcus may, however, be present in the blood of human patients in much greater numbers than these figures would seem to indicate (*vide* p. 125), as shown by the examination of the blood in a small series of cases this summer, when *M. melitensis* was once found to the number of 10,000 per cubic centimetre—a quantity of infective material in the blood stream comparing with that found in mild cases of malaria or very severe cases of streptococcic septicæmia.

Estimations were therefore made by weighing one of the empty mosquito tubes, transferring a captured mosquito to its interior and again weighing it—the difference being taken to represent the weight of the insect. The mosquito was immediately fed and again weighed, the difference in the weights of tube *plus* mosquito, before and after feeding, being regarded as the weight of the blood ingested, and may fairly be taken as sufficiently accurate for practical purposes. From a series of eight such weighings the average quantity of blood taken up by Stegomyia was 3 milligrammes, the extremes noted being 1·5 milligrammes and 5·5 milligrammes. *Stegomyia fasciata* was the species selected for the purpose of this experiment, on account of the

* *Vide* these Reports, I, p. 10, and III, p. 19.

readiness with which this insect bites even during the day time. Thus all the operations of weighing, feeding, and again weighing could be carried out out during the middle of the day, when the air temperature was at its maximum, and the air humidity, which is an important factor in Malta, where delicate weighings are involved, at its lowest point. The details of these weighings are given in tabular form below.

The amount of blood taken by a mosquito bears relationship to the elasticity of the skin of the abdomen rather than to the size of the insect, for of the two extremes noted the maximum, 0·0055 gramme blood, was ingested by a very small female—much smaller, in fact, than its weight (empty) would indicate.

Table XXII.—Showing Average Weight of *Stegomyia fasciata* before Feeding, and of Blood Ingested when the Insect was filled to Repletion.

No.	Weight of fasting mosquito.	Weight of mosquito *plus* blood—after feeding.	Weight of blood ingested at one meal (deduced from difference in weights given in Cols. II and IV).
	gramme.	gramme.	gramme.
1	0·0020	0·0035	0·0015
2	0·0020	0·0055	0·0035
3	0·0020	0·0065	0·0045
4	0·0030	0·0072	0·0042
5	0·0030	0·0085	0·0055
6	0·0080	0·0105	0·0025
7	0·0020	0·0045	0·0025
8	0·0010	0·0035	0·0025
Average	0·00262	0·00621	0·00333

3. *The Duration of Life of* M. melitensis *in the Body of the Mosquito.*

Since the species of mosquito common to the Island as a rule only feed upon the human subject at intervals of 48 hours, the first and most important points for consideration were (1) whether the mosquito would serve as a host for the micro-organism, and if so (2) the duration of life of the *M. melitensis* in the insect's body.

Previous workers* had isolated *M. melitentis* from the bodies of four mosquitoes (captured in the wards of hospitals where they had had opportunities of biting patients suffering from Malta Fever as well as patients suffering from other diseases, and also normal individuals),

* Horrocks and Kennedy, *vide* these Reports, IV, p. 72.

out of a total of 450 which they had dissected, and therefore disregarding the possibility of accidental external contamination of the mosquitoes, it was assumed to be proved that the mosquito could act as a host for *M. melitensis*, thus disposing of the first point.

With regard to the second point, the simplest method of determining the duration of life of the micro-organism within the insect's body would have been to feed a large number of mosquitoes simultaneously upon a patient suffering from Mediterranean Fever in whose blood *M. melitensis* was known to exist in large numbers; then to dissect several mosquitoes at regular intervals and prepare plate cultivations from the contents of the stomach, etc. The difficulties in carrying out such an experiment were great. Cases of Mediterranean Fever in the wards of the Military and Naval Hospitals were few in number and mild in character; moreover, Gilmour and Shaw had stated that the micrococcus could only be isolated from comparatively large quantities of blood, and that its presence was by no means constant. On humanitarian grounds, too, it did not appear justifiable to subject any one patient to the discomfort of being thus bitten by scores of mosquitoes in the prosecution of what were, after all, but preliminary observations.

Advantage was, therefore, taken of the fact that an extremely acute septicæmia, associated with the presence of numerous cocci in the peripheral circulation, can readily be induced in the guinea-pig by means of intracerebral inoculation of highly virulent cultivations of *M. melitensis*,* consequently this animal was substituted for the human subject and, with this modification, the experiments suggested above were initiated.

The procedure adopted was as follows :—

At 8 or 9 A.M., two or three guinea-pigs were successively anæsthetised and injected intracranially with 0·1 of a loop of a 24-hour-old culture of the highly virulent culture emulsified in 0·05 c.c. Advantage was taken of the insensibility of the animal to epilate a fair-sized area of the skin of the back between the shoulders. The temperature of the animal was then carefully watched. Usually, five or six hours later, or by 5 P.M. at latest, the temperature had reached 105° or 106° F., and was maintained at this level for many hours; with such a temperature it was known, as a matter of experience, that the circulating blood contained numerous cocci. The mosquito tubes already described, each containing an impregnated female mosquito, were then applied in turn, gauze covered end downwards, to the guinea-pig's back over the area of skin previously denuded of hair, and the insects allowed to fill themselves with blood. Immediately the entire batch of insects had fed, several insects were killed by ether vapour, placed in sterile Petri dishes and dissected at once. The bloody contents of

* Eyre, *vide* these Reports, II, p. 75.

the stomach were removed and emulsified with a small quantity of sterile salt citrate solution (0·75-per-cent. sodium chloride and 1-per-cent. sodium citrate in distilled water) and distributed over the surface of three or more nutrose-agar plates. After incubation, the colonies of *M. melitensis* that had developed were enumerated and their identity verified. This process was repeated at regular intervals, two or three insects being destroyed every 24 hours or so, and the contents of their stomachs plated, the unused insects being kept in a cage containing a vessel of water in which to lay their eggs, and supplied with fresh fruit, or retained in the separate feeding-tubes into which small cubes of apple or other fruit were introduce ddaily. In this way it was determined that the numbers of *M. melitensis* usually decreased as time went on, the greater number being voided with the droppings in the first 48 hours after feeding, but that in one or two instances the cocci appeared to actually multiply in the mosquito's stomach for a day or two, while it was certainly proved that living micrococci could be demonstrated in the interior of the mosquito four days after feeding on an infected animal.

4. *Experiments with* Acartomyia Zammitii.

The distribution of *Acartomyia Zammitii*, restricted as it appears to be to the Mediterranean littoral, and so corresponding to the chief incidence of Malta Fever, is held by some to give to this unique mosquito an especial claim to the carriage of the specific micro-organism of the Fever; and as moreover it is the first mosquito to appear in early summer in any considerable numbers, attention was first directed to it.

This insect, which has only comparatively recently been recognised as a distinct entity (being formerly regarded as a common Culex), is peculiar in that the early stages of its existence, from ovum to pupa, are passed in salt water. All around the coast line of the Island are rock pools above high-water mark filled with salt water, but not in direct communication with the sea, legacies of the stormy Grigali, a north-east wind which prevails from October to April. These pools remain isolated throughout the summer, and the contained salt water becomes highly concentrated from the evaporation that takes place during the hot weather.

The Acartomyia season begins in April or May, and is abruptly terminated by the first Grigali of winter. The larvæ of Acartomyia are to be found in practically all these rock pools, but are especially numerous in the half natural, half artificial salt pans in the neighbourhood of the northern and eastern coasts of the Island. It is interesting to note that a certain amount of discrimination is exercised by the female in the selection of water in which to lay her eggs. Sea water from the Mediterranean contains a larger percentage of salt

(2·72 per cent. sodium chloride) than open seas, and the average content of the more concentrated pools in which larvæ and pupæ are most abundant reaches a still higher figure (7·68 per cent.). Many attempts were made to induce the captive female to lay her eggs in fresh water or in ordinary sea water, but without success. Immediately, however, salt water of the necessary density was placed in the cage the eggs were deposited therein, even when the water was in a large glass vessel and had neither seaweed, *débris*, or empty pupa cases upon which the insect could rest during the process, and so was drowned at its termination. Again, if three vessels of water were placed simultaneously in a breeding cage containing females ready to lay their eggs, the first filled with fresh water, the second with ordinary sea water, and the third with concentrated salt water, all the eggs would be found deposited in the concentrated salt water within 24 hours, and none would be present in either of the other two vessels. The eggs are pointed ovals, averaging 0·5 mm. in length, white when first laid, but rapidly becoming brown and then black. They are laid singly or in pairs, or most commonly in rows resembling palisades, the individual eggs being arranged side by side. Under the ordinary conditions of nature, that is free exposure to air and sunlight, the eggs hatch out in from 24 to 72 hours. If transferred to fresh water immediately after being laid, the eggs do not hatch. Freshly hatched larvæ die if transferred from concentrated salt water to perfectly fresh water, but in the case of adult larvæ taken from their natural habitat and placed in tap water, development proceeds in a normal manner, but the remainder of the larval stage and the pupal stage are much prolonged. Some interesting observations on the habits of this mosquito have been recorded by Ross in a communication to the Liverpool School of Tropical Medicine.*

(a) *Duration of Life of* M. melitensis *in* Acartomyia Zammitii.

Working on the lines already indicated, several series of Acartomyia were fed on infected animals, then two or more destroyed after each of several intervals of time, the contents of the stomach of each plated out, and an enumeration made of the number of *M. melitensis* developing and the total contents of all stomachs averaged. In the later series the salivary glands were dissected carefully out and plated separately, but in no case was *M. melitensis* isolated from this situation. During the intervals between the platings the infected mosquitoes were kept alive by supplying them daily with fresh fruit, etc., or by regularly feeding them on alternate days on healthy monkeys in the attempt to transmit infection.

* Ross, E. H., "On the Habits of the Marine Mosquito (*Acartomyia Zammitii*)," Reports of the Liverpool School of Tropical Medicine, Memoir XVIII, 1906.

Table XXIII.—*Acartomyia Zammitii* as the Host of *M. melitensis*.

No. of series.	Source of infection.	Interval between feeding and dissecting.	Number of mosquitoes dissected and plated.	Average number of *M. melitensis* per stomach.	Average number of *M. melitensis* per pair of salivary glands.
I	Guinea-pig No. 6.........	12 hours	2	116	not examined
		48 "	3	3	" "
		72 "	2	nil	" "
		96 "	2	nil	" "
II	Guinea-pig No. 80	15 minutes	2	60	not examined
		24 hours	3	17	" "
		48 "	3	386	nil
		72 "	3	6000	nil
		96 "	2	813	nil
		144 "	2	nil	nil
III	Guinea-pig No. 112......	15 minutes	3	236	not examined
		48 hours	3	nil	nil
		96 "	2	nil	nil
IV	Guinea-pig No. 118......	15 minutes	2	673	not examined
		36 hours	3	2386	nil
		48 "	2	9243	nil
		84 "	2	nil	nil
		96 "	2	nil	nil

From these preliminary investigations it will be seen that in two of the series where the original meal of blood from the infected guinea-pig contained a fairly large number of cocci, the blood present in the stomach of the host proved a suitable nidus for the ingested micrococci and that multiplication proceeded for a limited period, but by the fourth or fifth day at latest the micrococcus had disappeared from the stomach of its host, whilst examination of the salivary glands invariably failed to demonstrate its presence. It is interesting to note, and is probably explanatory of the observation, that these two series comprised insects that had been fed upon healthy monkeys in the interval between 48 and 72 hours.

By establishing plate cultivations from the black and brownish droppings of the infected mosquitoes collected from the sides and corks of the mosquito tubes, the fate of the *M. melitensis* was explained, for the excrement was found to contain the micrococcus in large numbers for the few days following the feeding, and as long as any altered blood was being voided; as soon as the excrement regained its yellowish or white colour, the *M. melitensis* ceased to be demonstrable in it. The living coccus could also be recovered from excrement voided certainly 10 days previously. The full details of four of these series of investigations are here inserted (see Table XXIII).

(b) *Virulence of* M. melitensis *after Passage through* Acartomyia Zammitii.

Having thus determined approximately the duration of the stay of *M. melitensis* in the body of the mosquito and the path by which it leaves the insect, experiments were made to determine whether the coccus undergoes any vital change as a consequence of its sojourn in an insect host. In the first place cultivations of cocci, isolated from the mosquito stomach and from the droppings respectively, were employed to inoculate healthy guinea-pigs intracerebrally.

As in each case positive results were obtained, and the animals succumbed from an acute *M. melitensis* septicæmia, further experiments were carried out in which the infected blood contained in the stomachs of individual mosquitoes was inserted under the dura mater of the guinea-pig. These experiments also gave uniformly positive results, and the inevitable conclusion is that the coccus undergoes no loss of virulence in its passage through the body of the mosquito. Details of some of these experiments are inserted in Table XXIV (p. 86).

(c) Acartomyia Zammitii *as the Infective Agent.*

Attention was now directed to the question of the transference of *M. melitensis* to the monkey *viâ* Acartomyia, and for this purpose healthy monkeys in good condition which had been under observation, housed

Table XXIV.—Virulence of *M. melitensis* after Passage through Mosquito.

Guinea-pig No.	Dose of *M. melitensis*.	Source of *M. melitensis*.	Method of inoculation.	Result.
I	loop. 0·1	Culture from fæces of mosquito in Series I, Table XXIII	Intracranial	Death in 30 hrs. from *M. melitensis* septicæmia.
II	0·1	Culture from fæces of mosquito in Series I, Table XXIII	,,	Death in 30 hrs. from *M. melitensis* septicæmia.
III	0·1	Culture from stomach of mosquito 48 hours after feeding (Series II, Table XXIII)	,,	Death in 48 hrs. from *M. melitensis* septicæmia.
IV	Contents—blood and cocci—of stomach of Acartomyia 48 hours after feeding (*cf.* Series II, Table XXIII), mixed with 0·1 c.c. normal saline solution		Subdural	Death in less than 24 hrs. from *M. melitensis* septicæmia.

in mosquito-proof cubicles for a considerable period, and which had never shown any evidence of the presence of specific agglutinins in their blood were selected, and transferred to separate mosquito-proof cubicles on the Laboratory terrace. On the morning of the day on which it was to be subjected to the bites of the infected mosquito, the back of the thighs and legs of the experimental monkey were closely shaved, care being taken to avoid abrading the skin. The animal was then returned to its cage until the commencement of the experiment. When all was ready the animal was brought into the laboratory and stretched out face downwards on a table. The shaved areas of skin having been washed with distilled water and dried, the mosquitoes, each in its separate tube, were applied to the denuded spot and allowed to feed. This was often a tedious process and required some hours for its completion, and when using Acartomyia the feeding was often prolonged until after midnight; still, given adequate assistance in securing the monkey, as many as four of the mosquito-tubes could be manipulated by one worker.

In these experiments the process of feeding was carefully watched—to beguile the tedium of waiting as much as to ascertain the moment of repletion—and is here briefly described on account of the important bearing one feature of the process has upon the question of the infection of man through the agency of this insect. The mosquito having decided to feed, settles down at the gauze covered end of the tube, and after a few preliminary investigations with its proboscis, determines on

the point of skin to be punctured. Next the head and proboscis are lowered, while the body remains more or less horizontal. Then the hind pair of legs are raised to the level of the posterior part of the abdomen, and employed in massaging the abdomen by a series of stroking movements passing from the thorax towards the anus. These movements often, but not invariably, result in the extrusion of some of the intestinal contents which, in the case of insects previously fed on mammals, is easily recognisable by reason of its colour. This small mass of excrement drops either on to the gauze covering the tubes, or where the meshes are wide, actually on to the skin of the animal upon which the mosquito is feeding. In the meantime the abdomen of the insect has become distended with blood, and as soon as the mosquito has completed its meal the proboscis is withdrawn, stroked and cleaned by the help of the anterior pair of legs, and then the insect flies up to the upper part of the tube and settles down in a resting position. This sequence of events holds good in the case of other blood-sucking species of mosquito as well as Acartomyia.

Leaving now, for a moment, the region of observed facts for a short incursion into the realms of theory, it appears highly probable that a mosquito having fed on a case of Malta Fever in the acute septicæmic stage whose blood contained large numbers of the cocci, might, 48 hours later, settle upon a healthy individual and proceed to insert its proboscis into the skin. Massaging its abdomen, the mosquito then deposits a mass of bloody excrement, enclosing the coccus in a virulent condition, upon the surface of the skin, a few millimetres distant from the puncture made by its proboscis. The bitten individual, now alive to the fact that a mosquito is feeding upon him, rouses himself, frightens off the mosquito or kills it *in situ*, and promptly proceeds to thoroughly scratch the infective excrement into the site of the minute wound and, following a successful inoculation, an attack of Malta Fever ensues. Such a sequence of events is well within the range of possibility, and yet the necessary combination of factors is sufficiently uncommon to render this method of infection as rare as the experiments upon monkeys would indicate.

To return to the actual experiments—after feeding a number of infected mosquitoes upon the monkey, the animal was returned to its cubicle and carefully observed from day to day until some four to six weeks had elapsed, when the animal was killed and carefully examined *post-mortem*.

Of the experiments carried out with the aid of *Acartomyia Zammitii*, but one monkey was infected, and in this case the infection was an extremely mild one. The history of this experiment is as follows:—

Normal Monkey No. 175 was bitten, late at night, by six Acartomyia, which had fed between 48 and 50 hours before on Guinea-pig No. 71 (which succumbed to *M. melitensis* septicæmia 10 hours after

intracerebral inoculation, and the heart blood at the *post-mortem* examination was found to be absolutely teeming with the micrococci). The stomach contents of some of the mosquitoes, plated immediately after the termination of the feeding, yielded plates in which the colonies of *M. melitensis* were so numerous as to be absolutely uncountable. The bitten monkey was subsequently kept in a mosquito-proof cubicle, and every precaution which experience could suggest was taken to avoid any chance of accidental infection. The serum was tested on alternate days for the presence of *M. melitensis* agglutinins, and on the 11th day gave a positive reaction in dilution of 1 in 20. The serum value rose gradually, and on the 15th day had reacted 1 in 80, while an incomplete reaction was given with a dilution of 1 in 100. On the 21st day no reaction could be obtained, even with 1 in 10 dilutions, therefore the animal was killed. During the period of three weeks, in which the monkey was under observation, the temperature chart, which is here inserted, gave no indication whatever of a successful subcutaneous inoculation.

MONKEY 175.

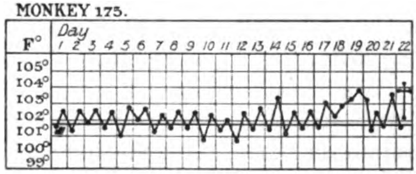


Chart 10.

At the *post-mortem* examination the spleen was found to be slightly enlarged, and all the superficial glands were markedly enlarged and congested.

In none of the plate cultivations prepared from heart blood, spleen pulp, and axillary and inguinal glands could *M. melitensis* be detected, but in one of the three tube cultures prepared from spleen pulp two colonies appeared of a minute coccus, which when tested against specific serum became agglutinated, although in a somewhat atypical manner. Subcultivations were prepared from these, and further investigation proved that one of the two colonies was composed of genuine *M. melitensis*.

In none of the other monkeys did the serum at any time during the period of observation contain specific agglutinins, nor could the presence of *M. melitensis* be detected in the blood. Finally, at the *post-mortem* examination *M. melitensis* was never recovered from any of the other organs or tissues.

Before tabulating the results of those of the Acartomyia experiments in which the value of each factor was accurately known, it may be useful to recapitulate the exact method of procedure—a reiteration which the importance of the subject alone condones:—

(*a*) First a healthy guinea-pig was inoculated intracerebrally with a sufficient dose of highly-virulent culture of *M. melitensis* to produce such an acute infection that in the course of a few hours large numbers of the cocci would be present in the peripheral blood.

(*b*) Next, when the temperature of the inoculated guinea-pig had reached 105° F. or 106° F. (a point which previous experience had shown corresponded to rapid multiplication of cocci in the blood), the first feeding of the mosquitoes was commenced.

(*c*) Several female mosquitoes—the number varying with the experiment from 20 to 70—each enclosed in a separate feeding tube, were applied one by one to a bare patch of skin between the infected guinea-pig's shoulders and encouraged to bite. As soon as one mosquito was seen to be full of blood, and to have settled to repose in another part of the tube, the tube was taken away, marked with its serial number, the number of the guinea-pig, and the date and time of feeding, and replaced by the next tube containing a fasting mosquito.

(*d*) During the progress of the feeding experiment, or immediately after its termination, some of the mosquitoes (the number varying in each experiment with the number of mosquitoes that had fed and were available) were killed with ether vapour, and the contents of the stomach plated out to determine the average number of cocci ingested with the blood of the guinea-pig. The feeding tubes containing the remainder of what may now, for purpose of reference, be termed "infected mosquitoes" were placed in test-tube racks and put on one side.

(*e*) Forty-eight hours after the primary feeding of the mosquito a healthy monkey was selected, stretched face downwards on a table, and the back of the fleshy part of each thigh and leg shaved, great care being taken to avoid cutting or grazing (this process was often carried out some hours earlier in the day). The shaved areas were washed with distilled water and partly dried with sterile wool.

(*f*) Each of the infected mosquitoes was now applied in turn to the shaved area, and allowed to bite the monkey and fill itself with blood. Some of course refused; these were put aside for feeding at 72 hours.

(*g*) At the termination of the feeding on the monkey two or three of the infected mosquitoes that had filled themselves were plated out to determine whether the contents of their stomachs still contained the *M. melitensis*, and to prove beyond question that the mosquitoes that bit the experimental animal actually contained infective material at the moment they were engaged in feeding on the monkey.

(*h*) At 72 hours after the primary feeding such infected mosquitoes as had refused to bite the first monkey (at 48 hours) and were still living, were applied to a second healthy monkey, and if they bit and filled themselves with blood the same routine was repeated.

Table XXV.—Transmission of *M. melitensis viâ* Acartomyia.

Infective agents.					Experimental animals.			
Source of infection.	Average number of *M. melitensis* per control mosquitoes. Immediately after feeding.	Average number of *M. melitensis* per control mosquitoes. At time of biting monkey.	Interval between primary feeding and biting monkey.	Number of mosquitoes employed in experiment.	No.	Date of appearance of serum reaction.	Duration of experiment in days.	*Post-mortem* findings.
			hours.					
Guinea-pig No. 90...	2426	2070	48	12	Monkey No. 177	—	34	nil
Guinea-pig No. 112...	236	nil	48	8	Monkey No. 186	—	28	nil
Guinea-pig No. 113...	673	9243		8				
Guinea-pig No. 71...	∞	∞	48	5	Monkey No. 175	11th day	21	1 colony of *M. melitensis* in one of the many cultures from spleen: other organs nil
Guinea-pig No. 72...	∞	∞	75	1	Monkey No. 176	—	43	nil
Guinea-pig No. 90...	2426	103	96	7	Monkey No. 178	—	32	nil
Guinea-pig No. 112...	236	nil	96	9	Monkey No. 187	—	26	nil
Guinea-pig No. 113...	673	nil						
Guinea-pig No. 90...	2426	nil	144	2	Monkey No. 179	—	24	nil

∞ = innumerable.

(*i*) At 96 hours after the primary feeding the infected mosquitoes (diminished in number as a result of death from natural causes or destruction for plating purposes) were applied to a third, and so on as long as any of the mosquitoes remained alive.

(*j*) The monkeys after being bitten were placed in mosquito-proof cubicles, and observed from day to day as to temperature and general condition, blood reactions, etc., until the termination of the experiment, when a careful *post-mortem* examination was carried out.

It was usual not possible to carry the above scheme beyond the 96 hours, owing to the death of the infected mosquitoes, as will be seen in Table XXV.

5. *Experiments with* Stegomyia fasciata.

Having dealt at some length with those mosquito experiments in which *Acartomyia Zammitii* was the species employed, those in which *Stegomyia fasciata* was employed as the infective agent may be briefly dismissed, for the technique was identical in both series of experiments.

(a) *Duration of Life of* M. melitensis *in* Stegomyia fasciata.—Experiments were made to determine the duration of life of *M. melitensis* in the stomach and intestines of Stegomyia in the manner already described (*vide* pp. 81 and 82), and the results obtained were very similar, for it was found that the micrococcus could rarely be recovered from this mosquito beyond four days after the primary feeding on the infected guinea-pig. The results of a few representative experiments are given below in Table XXVI:—

Table XXVI.—*Stegomyia fasciata* as the Host of *M. melitensis.*

No. of series.	Source of infection.	Interval between feeding and dissection.	Number of mosquitoes dissected and plated.	Average number of *M. melitensis* per stomach.
I	Guinea-pig No. 140	24 hours	2	∞
		48 "	2	6177
		72 "	3	*
		84 "	2	nil
II	Guinea-pig No. 150	30 minutes	3	∞
		48 hours	3	44
		96 "	2	nil
III	Guinea-pig No. 151	2 hours	1	∞
		24 "	2	44
		48 "	2	5
		72 "	2	*
		96 "	3	nil

∞ = innumerable.

* *M. melitensis* present, but plate unworkable owing to contamination with saprophytes probably derived from exterior surface of mosquito's abdomen.

(b) Stegomyia fasciata *as the Infective Agent.*—The experiments in which the attempt was made to transmit *M. melitensis* from the infected guinea-pig to the healthy monkey *viâ Stegomyia fasciata*, were planned and carried out in a manner identical with those detailed in connection with *Acartomyia Zammitii* (*vide* p. 86), consequently the technique need not again be described. The only point to be noted is that, as the solitary infection produced when Acartomyia was employed as the infective agent ensued when the mosquitoes bit a healthy monkey 48 hours after the primary feeding on the infected guinea-pig, the majority of the Stegomyia experiments were performed at that interval.

The possibility that infection might be produced as the result of puncturing the skin of the healthy subject by the soiled proboscis of a mosquito that had partly filled itself from an infected patient, was tested experimentally in one instance only, but in that single instance—as events subsequently proved—the conditions were exceptionally favourable to the transmission of the specific virus. The details of this experiment were as follows:—

One female Stegomyia, in its feeding tube, was applied to the back of an infected guinea-pig (prepared for the experiment by intracranial inoculation of *M. melitensis* 8½ hours previously) and allowed to settle down, insert its proboscis into the skin, and commence to feed. The instant that blood could be distinguished entering its abdomen, the feeding tube was removed and applied to the shaven leg—immediately over the external saphenous vein of Monkey No. 236, and the mosquito allowed to bite and complete its meal. Within half an hour of its removal from the monkey, the contents of this mosquito's stomach were plated out, but none of the plates that were prepared showed a single colony of *M. melitensis.*

Immediately the first mosquito had completed its meal, a second Stegomyia was applied to the guinea-pig and allowed to bite and about half fill its abdomen with blood. It was then transferred to the same monkey and applied, again over the external saphenous vein, at a point a centimetre or so above the first puncture. The mosquito settled down at once, inserted its proboscis, and proceeded to fill itself up with the monkey's blood. A short time after the mosquito had completed its meal, it was killed and the contents of its stomach plated out. Subsequent enumeration of the colonies of *M. melitensis* that developed on the plates showed that the stomach of this mosquito contained about 5000 cocci.

Following the feeding of the second mosquito, a third Stegomyia was half fed on the same infected guinea-pig and then transferred to the monkey and allowed to bite over the vein, just between the first and second mosquito bites, and complete its meal. All the plate cultivations prepared from the stomach contents of this third mosquito

Table XXVII.—Transmission of *M. melitensis viâ* Stegomyia.

Infective agents.					Experimental animals.			
Source of infection.	Average number of *M. melitensis* per mosquito.		Interval between primary feeding and biting monkey.	Number of mosquitoes employed in experiment.	No.	Date of appearance of serum reaction.	Duration of experiment in days.	*Post-mortem* findings.
	Immediately after feeding.	At time of biting monkey.						
Guinea-pig No. 140.........	∞	6,177	48	5	Monkey No. 207	—	44	nil
Guinea-pig No. 181.........	?	350	48	5	Monkey No. 228	—	37	nil
Guinea-pig No. 151.........	∞	44	48	18	Monkey No. 230	—	40	nil
Guinea-pig No. 150.........	∞	10,000	48	12	Monkey No. 232	—	69	nil
Guinea-pig No. 150.........	∞	nil	96	8	Monkey No. 231	—	38	nil
Guinea-pig No. 140.........	∞	4,855*	15 secs.	3*	Monkey No. 236	—	46	nil
Guinea-pig No. 170.........	22	320	48	1	Monkey No. 238	—	37	nil

∞ = innumerable.

* All three mosquitoes were killed and examined; *M. melitensis* was absent from the stomach of the first, present to the number of 4855 in the second, and in innumerable numbers in the third.

yielded pure growth of *M. melitensis*, in which the colonies were so numerous as to be absolutely uncountable.

The monkey that had been bitten by these three mosquitoes, however, remained perfectly healthy, specific agglutinins remained absent from its blood, and, when killed and examined *post mortem* 46 days later, showed no signs of infection with *M. melitensis*.

Two of the three mosquitoes, therefore, that first sucked blood from an infected guinea-pig and then finished their meal upon blood abstracted from a healthy monkey were conclusively shown to have taken up with the guinea-pig's blood a very large number of the micrococcus and, one would infer, had had ample opportunity of soiling the proboscis in each case, yet the monkey remained uninfected.

Details of the experiments in which the various data were accurately ascertained are tabulated below; other similar experiments were performed, but, owing to failure of plate cultures and other causes, there was no evidence as to the numbers, or, indeed, the presence of *M. melitensis*, in the interior of the mosquitoes used for biting. Such experiments being worthless, are not included in the results presented in Table XXVII.

The net result of the mosquito experiments may now be summarised very briefly. Out of 14 experimental monkeys bitten under conditions which have been accurately recorded (and disregarding a further six, where the necessary data are missing in whole or in part, but in none of which did infection occur), one monkey alone has given evidence of actual infection. In this one positive case, the *M. melitensis* contained in the stomach of the mosquito at the time it bit the monkey—48 hours after the primary feeding on the infected guinea-pig—were innumerable in quantity, and the inference is justifiable that, if excrement was dropped on the skin while feeding on the monkey, numerous living and virulent *M. melitensis* must have been present therein. Consequently, after removal from the operating table there was nothing to prevent this monkey (or, indeed, any of the experimental monkeys) scratching the infective material into the puncture, and this is quite possibly a case in which some such variety of infection occurred.

6. *Experiments with other Species of Mosquitoes.*

(a) *Theobaldia spathipalpis.*—The opinion has been freely expressed in some quarters that the members of this species are fruit feeders only, and never suck blood. This statement, however, does not hold good for Malta, as, during the summers of 1905 and 1906, whilst examining specimens of mosquitoes captured in various parts of the Island, *Theobaldia* was sometimes noted gorged with blood. One of the members of the Commission received several specimens in the course of the winter of 1905—1906, which had been "caught feeding" on the human subject, one of which had so recently fed that the blood

cells were unaltered and could readily be demonstrated microscopically. This particular specimen was submitted to Mr. E. E. Austen for confirmation of identity, and his reply is here inserted:—

Copy of letter from Mr. E. E. Austen.

BRITISH MUSEUM (Nat. Hist.),
CROMWELL ROAD,
LONDON, S.W.,
10*th January,* 1906.

Dear Sir,

I am very sorry that your letter of December 9th, enclosing a specimen of *Theobaldia* (*Culex*) *spathipalpis*, has remained so long unacknowledged. The letter arrived here while I was absent on a month's vacation, and since I have only just returned to duty, it was consequently impossible for me to reply sooner. Please forgive the delay.

Your identification of the species is perfectly correct, and the notes in your letter on its occurrence and blood-sucking habits in Malta are very interesting. I see you say that "it is described by Giles and Theobald as non-blood-sucking," but if you look at Theobald's monograph, vol. i, p. 341, you will see that the species is stated (apparently on the authority of Major Birt) to be "troublesome" in Gibraltar; it would appear, however, from the following page that Ficalni believes the species to be a vegetable feeder, and Grabham, writing with reference to Madeira in Theobald's monograph, vol. iii, p. 155, says "the people told me they had never observed this form attacking man or animals. They fed eagerly on banana slices, but never attempted to bite my hands."

It would be remarkable if *Theobaldia spathipalpis* should prove to be exclusively vegetarian in some localities, but a blood-sucker in others.

Believe me,
Yours very truly,
(Signed) E. E. AUSTEN.

Captain J. Crawford Kennedy,
R.A.M.C.

In view of these observations, numerous attempts were made to induce female *Theobaldia*, some captured and others bred in captivity, to bite infected guinea-pigs, but with negative results. Neither could they be persuaded to bite either monkeys or man.

(b) *Culex fatigans* and *Culex pipiens.*—For all practical purposes these two species are identical, and in breeding out in the Laboratory no attempt was made to differentiate between them.

Very few experiments were made with these mosquitoes, as it was

a matter of the greatest difficulty to induce them to feed on the guinea-pig in the first instance, or on the monkey in the second. Further, whilst on the one hand no infection resulted, on the other no proof of the infective character of the mosquito was forthcoming, as plate cultivations of the stomach contents were omitted—consequently the experiments referred to were worthless.

(c) *Anopheles maculipennis.*—No experiments were made with this mosquito, as its only breeding place is situated in a small, almost uninhabited valley in the centre of the island, and the imagines are not met with elsewhere than in its immediate vicinity. It is therefore obvious that this mosquito can have next to nothing to do with the dissemination of *M. melitensis*.

7. *Biting Flies*—Stomoxys calcitrans.

Although the experiments of Edmond and Etienne Sergent* have shown that *Stomoxys* does not usually act as the infective agent concerned in the transmission of the trypanosome of North African camel disease, the fact that one successful infection in the rat was produced through the medium of this fly, encouraged the hope that in the case of such a minute coccus as *M. melitensis* success might attend experiments in the direction of transmission of the micrococcus to the goat by means of this biting fly.

(a) *Duration of Life of* M. melitensis *in* Stomoxys calcitrans.—As in the case of the mosquito, an inquiry was first made into the ability of *Stomoxys* to act as the host to *M. melitensis*, and the experiments were conducted on identical lines. Abundant supplies of *Stomoxys* were readily obtained from stables, so that it was unnecessary to breed them. When captured they were placed in a fair-sized gauze-covered cage, brought up to the Laboratory, and, as the insects were for the most part caught whilst feeding on the horses or mules, they were usually kept for a day before using to enable them to dispose of the blood with which they were filled. They were then transferred singly to feeding-tubes similar to those used for mosquitoes.

A guinea-pig was then infected, and when its blood was crowded with the micrococci, flies, each enclosed in a feeding-tube, were applied in turn to an area of skin denuded of hair and allowed to fill themselves with blood.

It was soon found that the wastage from death was excessive unless these insects were fed every 24 hours; this necessitated feeding the balance left over after every plating period on a healthy guinea-pig every day, but even this plan did not entirely prevent the heavy mortality.

At varying intervals several flies were killed by ether vapour, dis-

* 'Annales de l'Institut Pasteur,' vol. 19, 1905, pp. 16 *et seq.*

sected, the contents of the stomach and intestines plated out, and the resulting colonies of *M. melitensis* enumerated.

Plate cultivations were also established from the droppings, and it was found that, as in the mosquito, the excrement contained numerous living *M. melitensis* for many hours after feeding upon the infected guinea-pig.

In the following table the results of a number of these experiments are arranged, and from that it will be seen that although the micrococcus has sometimes disappeared entirely from the alimentary tract within a couple of days, it may persist even up to five days.

Table XXVIII.—*Stomoxys calcitrans* as the Host of *M. melitensis.*

No. of series.	Source of infection.	Interval between primary feeding and dissection.	Number of Stomoxys dissected and plated.	Average number of *M. melitensis* per stomach and intestines.
I	Guinea-pig No. 72	15 hours	1	197
		24 "	1	nil
		36 "	1	19
		60 "	6	136
II	Guinea-pig No. 82	15 minutes	2	832
		24 hours	1	5
		48 "	1	nil
		72 "	1	nil
		96 "	1	nil
III	Guinea-pig No. 111	15 minutes	2	347
		18 hours	2	17
		40 "	2	5
		97 "	2	2
IV	Guinea-pig No. 122	15 minutes	5	2,248
		24 hours	3	nil
		48 "	3	nil
		86 "	3	nil
		100 "	3	400
V	Guinea-pig No. 150	2 hours	3	912
		90 "	2	nil
VI	Guinea-pig No. 162	1 hour	2	3300
		48 hours	2	nil
		120 "	6	50,352

(b) Stomoxys calcitrans *as the Infective Agent.*—The experiments in which infected Stomoxys were allowed to bite healthy animals were conducted on similar lines to the corresponding experiments with mosquitoes. Two points of difference only need noting.

In the first place, the kid which previous experiments had shown (*vide*

Table XXIX.—Transmission of *M. melitensis viâ* Stomoxys.

Infective agents.				Experimental animals.			
Source of infection.	Average number of *M. melitensis* per control *Stomoxys* immediately after primary feeding.	Interval between primary feeding and biting the kid.	Number of *Stomoxys* employed in the experiment.	Animal and No.	Date of appearance of serum reaction.	Duration of experiment in days.	*Post-mortem* findings.
Guinea-pig No. 72...	197	20	4	Kid No. 1 ...	—	70	nil
Guinea-pig No. 122...	2,000	20	9	Kid No. 2 ...	—	28	nil
Guinea-pig No. 122...	2,000	44	6	Kid No. 3 ...	—	27	nil
Guinea-pig No. 122...	2,000	112	3	Kid No. 6 ...	—	35	nil
Guinea-pig No. 162...	3,000	24	12	Kid No. 7 ...	—	9	nil
Guinea-pig No. 162...	3,000	48	6	Kid No. 8 ...	—	42	nil
Guinea-pig No. 162...	50,352	96 102 120	6 5 6	Kid No. 15 ...	—	40	nil

pp. 30 and 34) was extremely susceptible to subcutaneous and cutaneous inoculation, replaced the monkey as the experimental animal; and in the second place the infected *Stomoxys* were fed upon the healthy guinea-pig in the intervals between feeding on the kid. The results may be very briefly stated. In all, seven experiments were carried out, and in no case did infection of the kid with *M. melitensis* ensue, although in one of the experiments a kid was bitten by three separate batches of six, five, and six *Stomoxys* respectively during a period of 24 hours, at intervals of 96, 102, and 120 hours after the primary feeding on the infected guinea-pig. The details of these experiments are arranged in tabular form under the same headings as those used for the corresponding mosquito experiments on pp. 90 and 93.

8. *Fleas and Bugs.*

The experiments carried out with blood-sucking Hemiptera and Aphaniptera were few in number and of very questionable value, even when considered in relation to the negative evidence they produced, and may be very briefly dismissed.

Hemiptera—*Cimex lectularia.*—In view of the suggested association between certain cases of Malta Fever and venereal disease referred to by Kennedy* and the possibility of the infective virus being conveyed by domestic vermin, some 50 ordinary bed bugs were collected from low class brothels in the vicinity of the Camerata, Valletta, conveyed to the Laboratory and there killed and dissected. The stomach contents of each were then plated out in turn, but *M. melitensis* was never detected in, or isolated from, this situation. These were the only observations made with this parasite.

Aphaniptera (a) *Pulex irritans.*—No observations were made upon the human flea.

(b) *Pulex serraticeps.*—Dog fleas to the number of six were collected from a dog (which had been experimentally infected with *M. melitensis* by subcutaneous inoculation), killed, dissected, and plated, but no evidence could be obtained to show that they harboured the micrococcus.

(c) *Pulex scuirorum.*—Again 14 rat fleas were obtained from various rats which had been experimentally infected with *M. melitensis*, and in whose blood *M. melitensis* was swarming. After being similarly dissected the plate cultivations established from the stomach contents likewise failed in every case to show the presence of the coccus.

Two experiments were made in an endeavour to transmit *M. melitensis* from infected to healthy dogs through the agency of the flea:—

1. A healthy black terrier dog was inoculated subcutaneously

* Kennedy, 'Journ. Royal Army Med. Corps.,' vol. 4, 1905, p. 634.

behind the shoulder with emulsion containing the growth from three agar tubes of *M. melitensis*. Three weeks later the animal, which had in the interval shown definite signs of infection, was killed with chloroform vapour and the dead body placed close to, but not in contact with a bitch of the same variety for a period of 24 hours, in the hope that infected fleas would pass from the dead body as it cooled to the warm body of the living animal and so transmit the infection. *M. melitensis*, however, was only isolated *post mortem* from the inguinal and mesenteric glands of the terrier dog—not from the blood. The bitch never showed any sign of infection during an observation period of two weeks, and at the end of this time the second experiment was proceeded with.

2. Another black terrier dog which had been inoculated with a similar dose of *M. melitensis* six weeks previously, and like the first dog had given definite evidence of infection, was killed and placed alongside the same terrier bitch that had been utilised for the first experiment, for about 14 hours—precautions being taken to prevent contact of the healthy bitch with either carcase or excrement of the infected animal. This second dog when examined *post mortem* gave evidence of the presence of *M. melitensis* in spleen, inguinal and axillary glands, but the coccus was again absent from the blood.

The bitch never showed any signs of infection.

These two experiments are of course valueless from the scientific point of view, as the evidence available points to the absence of micrococci from the blood of the infected animal at the time of death, even supposing the dog fleas travelled from the carcase to the body of the living bitch.

Some further experiments were then made on somewhat similar lines with the rat flea. The rat had always been considered by the early workers with *M. melitensis* as insusceptible to infection with this organism, but it was observed by one of the members of the Commission that the rat, after intracranial inoculation, dies from acute septicæmia in about 24 hours, the micrococcus being present in the blood in enormous numbers for at least the last 12 hours of life; while after a few intracranial passages the coccus becomes exalted in virulence for this particular animal and readily produces an acute septicæmia after either intraperitoneal or subcutancous inoculation. Consequently in investigating the probability of the transmission of *M. melitensis* from the infected to the healthy rat, these highly virulent cultures were utilised.

In arranging these experiments, long rat cages were selected and divided into three compartments, a fair-sized one at either end, and a small narrow one in the centre, by means of two wire-netting partitions placed about 6 cm. apart. The meshes of the wire netting forming the partitions were about 0·5 cm. in diameter.

A couple of infected white rats were placed in one end compartment and two healthy rats in the other; all four rats were infested with large and vigorous fleas. The cage was then placed in a large rectangular zinc tray filled with lysol solution almost to the level of the floor of the cage. In the first experiment the infected rats died within 18 hours, and on the morning following the commencement of the experiment it was found that the other two rats had partly broken down the partitions and were occupying the same compartment as the dead rats.

The infected animals examined *post mortem* were noted to be quite free from fleas. The blood of each was crowded with the micrococci, as were spleen, kidneys, and all other organs.

The healthy rats died six hours after the infected animals, and at the *post-mortem* examination, which was conducted at once, no fleas could be found on the carcases, although shortly before death the animals were simply swarming with them. Many dead fleas were, however, found in the lysol moat surrounding the cage. From the *post-mortem* examination no evidence of infection could be obtained, as *M. melitensis* could not be detected in, or isolated from any of the tissues or organs.

This experiment was repeated a fortnight later in precisely the same manner.

Again the infected rats soon succumbed—one within nine hours, its companion within 22 hours after inoculation. No fleas could be detected on the carcases and no dead fleas were present in the lysol. *Post-mortem* blood and organs were crowded with micrococci.

The healthy rats were killed with chloroform seven days later and examined at once. Specific agglutinins were absent from the blood of each. Plate cultures from the blood and various organs failed to show any colonies of *M. melitensis*, neither could the micrococcus be detected in the bodies of the fleas caught on the bodies of these rats.

In both these experiments the *M. melitensis* was undoubtedly present in the infected rats, and the fleas upon them in all probability absorbed the cocci with the blood of their hosts. Further, it is a matter of common knowledge that fleas forsake the bodies of dead or dying rats for healthy living members of the same species, and in these experiments should have had ample opportunity of biting the healthy rats in the further compartment. Yet in neither of the four rats exposed to bites from presumably infected fleas did infection with *M. melitensis* ensue and the results were absolutely negative.

V.—Naturally Acquired Infection (*M. melitensis*) in Various Animals.

During 1905 numerous observations were carried out upon various animals during life to determine whether infection with *M. melitensis*

occurred naturally. These observations were usually limited to an examination of the blood for *M. melitensis* agglutinins, but were followed in a few cases by *post-mortem* examination. As a result of these examinations, it was clearly shown that cows and dogs living in the Island acquired naturally an infection with *M. melitensis*, while from the presence of positive serum reactions in low dilutions, it was suggested that mules were also susceptible to the pathogenic action of the coccus.

Similar observations were continued during the summer of 1906, as many various species of animals being examined as opportunity permitted, and the results noted are here recorded.

1. *Rats.**—The close association of epizootic plague in the rat and epidemic plague in man suggested the possibility of a similar association between the rat and Malta Fever, but inquiry amongst residents in the Island failed to support this view.

Arrangements were then made for the supply of sewer rats from the dockyard and from the Valletta sewers for examination in the Laboratory. Owing, however, to the frequent and prolonged absence of the Fleet from Malta, the number of rats obtainable from the dockyard was small; it also proved a matter of greater difficulty to obtain the rodents from the Valletta sewers, even a capitation fee of 3*d.* per head failing to secure the necessary material, so that a total of 84 rats examined during the months of May, June, and August is all that could be obtained. During May and June, the rats on arrival at the Laboratory were sorted out into cages and numbered, and blood collected from each to afford serum for the agglutination reaction, and also for planting out for the recovery of *M. melitensis*, and it was intended that a complete *post-mortem* examination should be made only when specific agglutinins were detected in the blood.

Table XXX.—Examination of Sewer Rats.

Month, 1906.	Number of rats examined.	Serum reaction.	*M. melitensis* in	
			Blood	Other organs.
May............	72	Absent	Absent	Not examined.
June	6	"	"	"
July	0	—	—	—
August	8	Absent	Absent	Absent

In July no sewer rats at all could be obtained, but during that month experiments were carried out which showed that while the rat was susceptible to infection with the micrococcus, agglutinins were not usually formed during the course of the disease, and consequently a

* Compare these Reports, V, p. 40.

complete *post-mortem* was performed on the eight rats that were available during August.

The results of these examinations were completely negative. None of the specimens of rat blood that were examined yielded an agglutination reaction even in low dilutions, and *M. melitensis* was never recovered from blood or organs.

Several dozen white rats, bred on the Island and purchased for experimental work, were also tested before use as to the presence of the serum reaction to *M. melitensis*, likewise with negative results.

2. *Dogs.**—Forty-six stray dogs were examined between the beginning of March and the end of August for the presence of *M. melitensis*, and of these three yielded a positive reaction—one in dilution of 1 in 10, one in dilution of 1 in 20, and a third in all dilutions up to 1 in 100. Although a reaction obtained in a dilution of 1 in 20 is by no means absolute or even satisfactory evidence of infection, all three of these animals were killed and examined *post mortem*, but *M. melitensis* was never recovered from any of the organs or tissues.

Table XXXI.—Examination of Stray Dogs.

Month.	Number of dogs examined.	Serum reaction.	*M. melitensis* in	
			Blood.	Other tissues and organs.
March	10	1 × 1 in 10	Not examined	Not examined.
April	13	Absent	"	"
May	0	—	"	"
June	0	—	"	"
July	0	—	"	"
August	23	1 × 1 in 20	Absent	Absent
		1 × 1 in 100	"	"

3. *Guinea-pigs.*—The numerous guinea-pigs employed in the experimental work were all bred on the Island, and as a preliminary precaution the blood was carefully examined in many different dilutions with reference to the presence of specific agglutinins. These substances, however, were invariably absent from the blood.

4. *Mules.**—Some mules were imported into Malta from Sicily at the beginning of 1906. Steps were taken to examine their blood as soon as possible after arrival. As a result of this examination the blood from each of these mules yielded a partial or incomplete reaction with serum in low dilution (1 in 10), but no reaction whatever could be obtained in higher dilutions.

Six months later the blood from these same nine mules was again

* Compare these Reports, III, p. 85 *et seq.*

Table XXXII.—Examination of Mules.

No. of mule.	Date of arrival in Malta.	Date of first examination.	Agglutination value of mule's serum.	Nature of sickness, if any, recorded between February and August, 1906.	Date of second examination.	Agglutination value of mule's serum.
48,396	19/2/06	15/3/06	1 : 10 ±	Girth gall	28/8/06	1 : 200 +
48,397	19/2/06	15/3/06	1 : 10 ±	Nil	28/8/06	1 : 10 +
48,398	19/2/06	15/3/06	1 : 10 ±	Nil	28/8/06	nil
48,399	19/2/06	15/3/06	1 : 10 ±	Girth gall : swollen sheath	28/8/06	1 : 10 ±
48,400	19/2/06	15/3/06	1 : 10 ±	Castration	28/8/06	nil
48,401	19/2/06	15/3/06	1 : 10 ±	Set fast	28/8/06	1 : 500 +
48,402	19/2/06	15/3/06	1 : 10 ±	Breast harness gall	28/8/06	1 : 10 ±
48,403	19/2/06	15/3/06	1 : 10 ±	Sore breast : lame	28/8/06	1 : 200 ±
48,404	19/2/06	15/3/06	1 : 10 ±	Nil	28/8/06	1 : 500 ±

examined, with the result that one reacted well and one incompletely in dilution of 1 in 500; two others reacted, one completely and one incompletely in dilutions of 1 in 200. The serum reactions of the remaining mules remained practically unaltered.

Judging these results from the alteration in their serum values, it is practically safe to assume that two of the mules (Nos. 48,401 and 48,404) had acquired *M. melitensis* infection during the course of their first summer in Malta, and probably Nos. 48,396 and 48,403 had also become infected. The absence of any serious sickness in these animals needs no comment in view of the lack of constitutional symptoms in the infected goats. Unfortunately, *post-mortem* examination of these animals was not possible. The results of these examinations are given in Table XXXII.

5. *Horses.*—In order to obtain some idea as to the prevalence of *M. melitensis* infection in the horse—as judged by the serum reaction standard—samples of blood from 100 horses attached to the Mounted Infantry camp at Ghain Tuffeiha were examined.

The results obtained were as follows :—

Negative reaction				54
Incomplete	reaction in	1 in 10	dilution	14
Complete	„	„	„	11
Incomplete	„	1 in 20	„	11
Complete	„	„	„	7
Incomplete	„	1 in 50	„	2
Complete	„	„	„	1
				100

It will thus be seen that the agglutination reaction was obtained in varying dilutions in 46, the test proving absolutely negative in 54. In 14 of those animals yielding a reaction of some sort, the result of the test was "incomplete," clumping with 1 in 10 dilutions, and as such a reaction is valueless as evidence of infection, these animals may be disregarded. Again, neither a complete reaction in a dilution of 1 in 10, nor an incomplete reaction in dilution of 1 in 20 can be regarded as incontrovertible evidence, and at any rate, in the case of the human subject, neither would be accepted as deciding a question of diagnosis. Eliminating such animals as did not give a positive reaction in at least as high a dilution as 1 in 20—and even this standard is open to question—10 animals are left which show signs of infection by *M. melitensis,* three, indeed, in a marked manner. Unfortunately, no further examination of these infected animals was possible.

One of the animals (No. 95) was subsequently shot, and examined *post mortem.* During life the titre of its serum, when tested against

Table XXXIII.—Examination of Horses.

Serial No.	Service in Malta.	Agglutination value of serum.	Previous medical history.	Present condition.
6	2 years	1 : 10 ±	Nil	Good
25	5 "	1 : 10 ±	One attack colic	Good
27	5 "	1 : 10 ±	Nil	Good
42	5 "	1 : 10 ±	Two attacks colic: one attack catarrh	Good
98	5 "	1 : 10 ±	Nil	Good
113	—	1 : 10 ±	—	—
117	5 years	1 : 10 ±	One attack catarrh	Good
119	5 "	1 : 10 ±	Nil	Good
120	5 "	1 : 10 ±	Nil	Good
125	2 "	1 : 10 ±	Nil	Fair
126	2 "	1 : 10 ±	Nil	Good
138	1 year	1 : 10 ±	Nil	Good
140	4 years	1 : 10 ±	Two attacks colic: one attack horse-pox	Good
145	1 year	1 : 10 ±	One attack diabetes	Poor
2	6 years	1 : 10 +	One attack stomatitis	Fair
23	6 "	1 : 10 +	Nil	Good
30	5 "	1 : 10 +	Two attacks colic	Fair
43	2 "	1 : 10 +	Nil	Good
72	6 "	1 : 10 +	One attack catarrh	Fair
75	6 "	1 : 10 +	Nil	Good
95	6 "	1 : 10 +	Nil	Good
103	5 months	1 : 10 +	Nil	Fair
114	6 years	1 : 10 +	Nil	Good
130	5 months	1 : 10 +	Nil	Good
137	5 "	1 : 10 +	Nil	Fair
9	6 years	1 : 20 ±	Nil	Good
18	6 "	1 : 20 ±	One attack catarrh	Fair
22	6 "	1 : 20 ±	Nil	Good
56	6 "	1 : 20 ±	Nil	Good
58	5 "	1 : 20 ±	Nil	Good
59	5 "	1 : 20 ±	Nil	Good
61	5 "	1 : 20 ±	One attack strangles	Good
70	5 "	1 : 20 ±	Nil	Good
82	6 "	1 : 20 ±	Nil	Good
91	5 "	1 : 20 ±	One attack catarrh	Good
127	6 "	1 : 20 ±	One attack catarrh	Fair
37	6 "	1 : 20 +	One attack pink eye	Good
38	2 "	1 : 20 +	Nil	Good
66	6 "	1 : 20 +	Nil	Good
71	6 "	1 : 20 +	Nil	Good
115	6 "	1 : 20 +	Two attacks catarrh	Good
129	6 "	1 : 20 +	Two attacks debility	Fair
143	1 year	1 : 20 +	Nil	Fair
64	2 years	1 : 50 ±	Nil	Good
74	6 "	1 : 50 ±	Nil	Good
94	6 "	1 : 50 +	Nil	Good

M. melitensis, was 1 in 10. The micrococcus could not, however, be detected in either blood, spleen, or inguinal or mesenteric glands. Three other horses (Nos. 11, 35, and 52), whose blood during life showed no signs of the presence of agglutinins, were examined *post mortem*, but with completely negative results so far as related to the presence of *M. melitensis*.

Details of the animals, relating to the length of service in Malta with the Mounted Infantry, their present condition, and previous medical history, were kindly supplied by the commanding officer, Captain Salmon, and such of those details as refer to horses that gave a serum reaction are given in Table XXXIII.

VI.—*M. melitensis* Infection by Means of Personal Contact.

The incidence of Malta Fever upon cases admitted to naval and military hospitals for venereal disease, although probably due to infection by means of the goats' milk that forms the staple article of diet of the men during the first days of treatment, at once raises the suggestion that simultaneous infection might occur during sexual connection through minute lesions of the mucous membrane of the glands or prepuce, especially when considered in conjunction with the existence of *M. melitensis* in the urine of so-called ambulatory cases of the disease. In these latter cases febrile disturbance is extremely slight or entirely absent, as indeed are clinical symptoms of any kind, although at the same time the patient, male or female, may be passing *M. melitensis* in thousands per cubic centimetre in the urine.

Writing in the 'Journal of the Royal Army Medical Corps,'* Kennedy stated that of the cases which developed Malta Fever after admission to the military hospital for some other disease, by far the larger proportion were venereal cases. The experience of the authorities at the Royal Naval Hospital appears to be very similar.

Following up this line of enquiry, the before-mentioned observer collected in 1905, and followed out, a series of 124 cases, 20 of which had been under treatment for venereal disease during some portion of the couple of months preceding the diagnosis of Mediterranean Fever. Again, of these 20 cases the probability of infection contracted within the hospital could be excluded with tolerable accuracy in 12, viz., 6 cases of gonorrhœa, 1 of soft sore, and 5 of syphilis.

Under these circumstances an enquiry was instituted into the medical history of the common prostitutes of Malta. The investigation was much facilitated owing to the fact that the bulk of these women are Italians or Sicilians and, therefore, coming under the law with regard to aliens, are registered by the police, their addresses are known, and a

* Kennedy, J. C., "Malta Fever in the Military Hospital, Valletta, Malta, during the years 1897—1904," 'Journ. R.A.M.C.,' vol. 4, 1905, pp. 634—646.

Table XXXIV.—Positive Results of Agglutination Test.

No.	Initials.	Duration of residence in Malta.	History of attack of Malta Fever.	Serum value.					
				1 : 5.	1 : 10.	1 : 20.	1 : 50.	1 : 100.	1 : 200.
94	N. A.	9 months	Negative	+	±	−	−	−	−
95	C. A.	20 „	„	+	±	−	−	−	−
96	R. A.	1 year	„	+	±	−	−	−	−
97	C. C.	20 months	„	+	±	−	−	−	−
98	C. C.	?	„	+	±	−	−	−	−
99	A. C.	3 months	„	+	±	−	−	−	−
100	V. C.	4½ years	„	+	±	−	−	−	−
101	R. C.	1½ „	„	+	±	−	−	−	−
102	C. G.	4½ „	„	+	±	−	−	−	−
103	A. M.	7 „	„	+	±	−	−	−	−
104	E. R.	6 „	„	+	±	−	−	−	−
105	V. T.	8 months	„	+	±	−	−	−	−
106	D. A.	2 years	„	+	+	−	−	−	−
107	C. C.	Native	„	+	+	−	−	−	−
108	G. C.	„	Oct. to Dec., 1905	+	+	−	−	−	−
109	G. N.	12 years	Negative	+	+	−	−	−	−
110	A. S.	?	„	+	+	−	−	−	−
111	C. B.	5 months	„	+	+	+	−	−	−
112	C. B.	Native	„	+	+	+	−	−	−
113	G. C.	9 months	„	+	+	+	−	−	−
114	M. C.	16 years	„	+	+	+	−	−	−
115	F. D.	1½ „	„	+	+	+	−	−	−
116	R. G.	9 months	„	+	+	+	−	−	−

117	G. L.	1½ years	”	+	+	+	−	−	−
118	C. M.	Native	”	+	+	+	−	−	−
119	R. M.	”	”	+	+	+	−	−	−
120	R. T.	5 years	”*	+	+	+	−	−	−
121	G. T.	6 ”	Negative	+	+	+	−	−	−
122	G. C.	4 ”	”	+	+	+	+	−	−
123	A. C.	Native	”	+	+	+	+	−	−
124	F. C.	”	”	+	+	+	+	−	−
125	G. D.	5 years	”	+	+	+	+	−	−
126	M. D.	8 ”	”	+	+	+	+	−	−
127	G. S.	6 ”	”	+	+	+	+	−	−
128	F. S.	1½ ”	”	+	+	+	+	−	−
129	C. G.	Native	Sept. to Dec., 1904	+	+	+	+	+	−
130	A. M.	”	Negative	+	+	+	+	+	−
131	A. M.	3½ years	”	+	+	+	+	+	−
132	A. T.	2 months	”	+	+	+	+	+	−
133	F. T.	10 years	”	+	+	+	+	+	−
134	B. A.	5 months	Jan., 1906	+	+	+	+	+	+

* Rheumatism (?) March, 1906.

tri-monthly medical examination is carried out by certain district medical officers.

Preliminary enquiries elicited a definite history of an attack of Malta Fever varying in duration from two to twelve weeks in 3, and a history of "rheumatism" suspiciously like the neuritis associated with the Fever in 1, out of a total of 147 registered women. Next, specimens of blood were collected from 134 of those previously interviewed—the remaining 13 refusing to allow either finger or ear to be pricked in order to obtain samples—for the purpose of carrying out the agglutination test. Of these 134, 93 (or 69·4 per cent.) gave a completely negative reaction, 12 (or 8·95 per cent.) a slight reaction, indicating probably either a recent extremely mild or very remote attack of Malta Fever, and 29 (or 21·64 per cent.) yielding reactions that pointed to present or recent more severe infections.

Combining these two latter classes, it will be seen that no less than 41 out of a total of 134, or 30·59 per cent., exhibited evidence of *M. melitensis* infection.

The next step was to obtain vaginal swabbings and specimens of urine from such of the prostitutes as yielded a positive serum reaction and, by means of plate preparations, endeavour to determine the presence or absence of *M. melitensis* from these situations.

Of the 41 women yielding positive serum reactions, five, finding their occupation gone owing to the absence of the Fleet from Malta, returned to their homes in Sicily, and further specimens could not be obtained from them; four more absolutely refused to permit swabbings or specimens of urine to be taken; the remainder, 32 in number, afforded specimens for examination on one, two, or three several occasions.

In the collection of these specimens the vaginal swabbings were taken on ordinary sterile swabs such as are employed for collecting diphtheritic material (a piece of absorbent wool twisted round the end of a 15-cm. length of iron wire, enclosed in a test-tube, and the whole sterilised by dry heat), from just within the vaginal orifice or from some portion of the lower third of the vaginal wall. A Sims speculum was then passed into the vagina and the mouth of the os uteri exposed, and some of the cervical mucus collected on other sterile swabs. With regard to the urine samples, it was rarely possible to obtain catheter specimens, and, consequently, after the vaginal swabbing had been taken, a sterile, wide-mouthed bottle was handed to the woman and she was instructed to pass water directly into it. In this way, although asepsis was somewhat neglected, specimens of urine remarkably free from extraneous germs were usually obtained.

On arrival at the Laboratory, plate cultivations were prepared from each of the specimens as follows:—

Vaginal or Cervical Swabbing.—With a pair of sterile forceps the end

of the swab wire was bent up at right angles so as to form an L-shaped rod, the infected cotton-wool occupying the short arm. Using the instrument now as a spreader, the swabbing was smeared over the surface of three nutrose agar plates in succession, and the plates numbered in the order of their inoculation.

Urine.—(*a*) One-tenth of a cubic centimetre of the urine sample was evenly distributed over the surface of each of four nutrose agar plates by means of a sterile L-shaped glass rod.

(*b*) Twenty cubic centimetres of the urine sample were transferred to a sterile centrifuge tube and thoroughly centrifugalised. Nearly all the supernatant fluid was pipetted off and the deposit shaken up with the remaining half cubic centimetre of urine, taken up in a sterile pipette and divided between two Petri dishes of nutrose agar. By means of a glass spreader, the urine deposit was distributed all over the surface of the first plate, and with the same instrument two further nutrose plates were inoculated in series. The remainder of the urine deposit, placed on the second plate, was distributed over it in like manner by the help of a second spreader, and two further plates inoculated in series with it.

After inoculation and labelling with distinctive number, etc., all the plates were transferred to the incubator at 37° C., and kept under observation up to the end of seven days. All suspicious colonies were tested by means of a serum of high titre, and those reacting were verified by tinctorial and cultural tests.

The details of the examinations are given in tabular form (p. 112), but the results may be briefly summarised as follows:—

(1) *Urine.*—*M. melitensis* recovered on five occasions from four patients.

(2) *Cervical Mucus.*—*M. melitensis* never recovered from this situation.

(3) *Vaginal Swabbings.*—*M. melitensis* recovered on two occasions from one patient convalescent from an attack of Malta Fever, and on one occasion from a patient who had suffered from a severe attack 18 months previously.

In connection with the isolation of *M. melitensis* from vaginal swabbings, it is interesting to note that the micrococcus was isolated from the the same situation, and also from the milk and the urine in the case of a married woman, Mrs. A., about a week after her discharge as convalescent from the Married Families (Military) Hospital at Valletta.

In view of the foregoing results an attempt was made to determine experimentally the possibility of infection taking place through the genital mucous membrane—a possibility which was rendered the more probable by reason of Shaw's successful infections through the apparently intact conjunctival mucous membrane (see these Reports, V, p. 10).

Table XXXV.—Examination of Urine, etc.

No. (*cf.* Table XXXIV).	Initials.	Urine.		Vaginal swabbings.		Cervical mucus.	
		No. of examinations.	*M. melitensis* recovered.	No. of examinations.	*M. melitensis* recovered.	No. of examinations.	*M. melitensis* recovered.
94	N. A.	3	0	3	0	2	0
95	C. A.	1	0	1	0	1	0
100	V. C.	3	0	3	0	2	0
101	R. C.	3	0	3	0	2	0
103	A. M.	3	0	3	0	2	0
104	E. R.	1	0	1	0	1	0
106	D. A.	2	0	2	0	1	0
107	C. C.	3	0	3	0	2	0
108	G. C.	1	0	1	0	1	0
109	G. N.	2	0	2	0	2	0
111	C. B.	1	0	1	0	1	0
112	C. B.	2	0	2	0	2	0
115	F. D.	2	0	2	0	1	0
116	R. G.	1	0	1	0	1	0
117	G. L.	2	0	2	0	2	0
118	C. M.	2	0	2	0	2	0
119	R. M.	3	0	3	0	3	0
120	R. T.	2	0	2	0	1	0
121	G. T.	2	0	2	0	1	0
122	G. C.	1	0	2	0	1	0
123	A. C.	2	0	2	0	2	0
124	T. C.	1	0	1	0	1	0
125	G. D.	1	1	1	0	1	0
126	M. D.	2	0	2	0	1	0
127	G. S.	3	0	2	0	1	0
128	F. S.	2	0	2	0	2	0
129	C. G.	1	1	1	1	1	0
130	A. M.	3	0	3	0	2	0
131	A. M.	2	0	2	0	2	0
133	F. T.	2	2	2	0	1	0
134	B. A.	2	1	2	2	2	0

A prolonged search was first made for an infected milch goat which should combine the two factors—readiness for impregnation and the excretion of urine containing *M. melitensis*—but without success; consequently the demonstration of the infection of the healthy male goat as a sequent to covering the suitable infected female had perforce to be abandoned. Monkeys were available but proved refractory owing to the vicious nature of the females, and pairing was unsuccessful. Finally, two healthy male monkeys were selected; first one and then the other was securely held on the operating table, the glans penis exposed and carefully examined with a hand lens for scratches and abrasions. As the mucous membrane in each case appeared to be intact, the following experiments were made:—

(1) A strip of cotton-wool was first dipped in a fresh specimen of urine from an ambulatory case of Malta Fever (under observation in H.M. Naval Dockyard), then wrapped around the glans penis of Monkey No. 203 and left in contact with the mucous membrane for a period of half a minute. The wool was then removed, the glans mopped dry with sterile cotton-wool and the monkey returned to his cubicle.

The specimen of urine was then plated out and the subsequent growth showed the presence of 500 colonies of *M. melitensis* per cubic centimetre.

On the 17th day the blood serum of Monkey No. 203 in dilution of 1 in 20 caused typical clumping of *M. melitensis*. The titre of the serum gradually rose until on the 28th day it had reached 1 in 150. The animal was then killed with chloroform vapour, and at the *post-mortem* examination the micrococcus was recovered in large numbers from right and left inguinal glands, and in smaller numbers from the right axillary gland and the spleen, but was absent from the blood; the *post-mortem* also revealed the fact that this monkey was the subject of miliary tuberculosis.

(2) After exposing the glans of Monkey No. 200 it was first dried with sterile cotton-wool, and then a small area of the surface was rubbed with a dry, hard pad of sterile cotton-wool to produce a "friction" excoriation. A piece of wool soaked in the same specimen of urine that was used for the first experiment was wrapped around the glans and left in contact for 30 seconds. It was then removed, the glans dried and the monkey returned to his cage.

On the 17th day an agglutination reaction in dilution of 1 in 10 was obtained and by the 28th day the serum value had risen to 1 in 200. The animal was killed on this day and at the *post-mortem* the *M. melitensis* was recovered from the blood—to the number of about 10,000 per cubic centimetre—and in large numbers from the spleen, the axillary, inguinal, and mesenteric glands.

Both these experiments, therefore, yielded positive results, infection taking place in the first case by absorption of the coccus through an

Table XXXVI.—Infection of Monkey *viâ* Mucous Membranes.

No. of monkey.	Sex.	Condition of exposed surface of mucous membrane of glans penis.	Infective material.	Serum reaction.		Duration of experiment in days.	*Post-mortem* findings.							
				Day of appearance.	Amount of dilution.		Value of serum.	*M. melitensis* recovered from—						
								10 c.mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
203	♂	Apparently intact.	Urine from ambulatory case of Malta Fever (1857), see p. 128	17	1 : 20	28	1 : 150	—	+	—	+	+	—	+
200	♂	Friction excoriation.	Ditto	17	1 : 10	28	1 : 200	1000	+	+	+	+	+	+

apparently uninjured and intact mucous membrane, and in the second case probably through the artificially produced lesion—in both the incubation period extended to 17 days, an interval between exposure to infection and the first appearance of symptoms which tallies very closely with those noted by Shaw in the experiments previously referred to.

VII. Prophylactic Inoculation with *M. melitensis* Vaccine.

The results that had attended the use of *M. melitensis* vaccine during the winter of 1905–6 by one of the members of the Working Party in the treatment of cases of Malta Fever after return to England, encouraged the hope that its employment as a prophylactic vaccine might be a measure of practical utility, and arrangements were made to put it to the test.

As the records of the Royal Naval Hospital at Bighi and of the R.A.M.C. Detachment in Malta showed an abnormally high case-incidence amongst those men whose duty it was to nurse Malta Fever patients, it was decided to limit the vaccination for the summer of 1906 to this section of the community. The plan being explained to the men, a sufficient number of the Sick Bay Staff and Nursing orderlies expressed their desire to submit to the inoculations, to admit of the full strength being divided into two nearly equal batches both at the Military and the Naval Hospitals—one section at each institution being untouched or injected merely with sterile saline solution to serve as controls.

The Subjects—Naval.—Of the staff of the Naval Hospital at Bighi, 43 men were available for observation in this connection, of whom 23 were vaccinated (7 on one occasion only and 16 on two occasions) and 20 were reserved as controls. From the 23 vaccinated men, however, two must be deducted, for the danger that must always exist in carrying out a series of vaccinations within the endemic area was here

Table XXXVII.—Incidence of Malta Fever on the Bighi Hospital Staff.

	1901.	1902.	1903.	1904.	1905.	1906, Jan.—April.
Members of Sick Berth Staff exposed to infection	31	51	65	75	80	43
Number contracting Malta Fever........................	5	19	12	16	12	13

encountered and two of the men were vaccinated—each with a dose of 200 millions of cocci—during the *incubation period* of the

naturally acquired disease. This leaves 21 inoculated men and 20 controls who were under observation from April 27th to August 30th, 1906. During this period one of the controls contracted the disease, but no cases occurred amongst the vaccinated men.

The incidence of Malta Fever on the Sick Berth Staff during previous years is shown in Table XXXVII.

Military.—The strength of the Valletta detachment of the Royal Army Medical Corps (R.A.M.C.) at the commencement of the experiment comprised 84 men, of whom 12 had already suffered from an attack of Malta Fever, and four were then in hospital. This left a balance of 68 available for the purposes of observation. Of these 30 volunteered for inoculation, the remaining 38 served as controls. The fallacies involved in such a division have already been threshed out in connection with prophylactic inoculations of typhoid vaccine, and need not be further enlarged upon here. Suffice to say, that of the inoculated men 15 received one injection only, and 15 received two injections; and during the four months, from April 26 to August 30, 1906, that the men were under the observation of the operator, two cases occurred amongst the non-vaccinated controls, and none in the vaccinated men.

At the beginning of September, however, two cases occurred in the vaccinated men. The first, Lance-Corporal Johnson, assistant in the Commission Laboratory at Valletta, who had been injected twice with a dose of 400 millions of cocci on each occasion, and whose serum value had reached 1 in 50, suffered a typical attack, and the second, Private Boyd, who had been inoculated once only with a similar dose, and whose serum had a value of 1 in 30.

Owing to the distribution of the units of the detachment over the whole island for duty at the various military hospitals, and the frequent changes of station that take place, it is difficult to tabulate the incidence of Malta Fever in that portion of the detachment stationed at Valletta Hospital. Dealing, however, with the period January 1 to April 30, 1906, in an average strength of 81 (including 12 who had already suffered from the disease), five cases of Malta Fever occurred, whilst during the period May 1 to August 21, 1906, with a strength similar in numbers and composition, only two cases, both in non-vaccinated controls, occurred.

The Vaccine.—The vaccine employed was the remainder of a batch prepared and bulbed on March 16, 1906, in the Bacteriological Department of Guy's Hospital. The method of preparation varied in no respect from that usually adopted, and may be briefly described, first premising that all apparatus and solutions employed must be absolutely sterile, and every operation carried out under strictly aseptic conditions and with every possible precaution to avoid the entrance of extraneous micro-organisms.

A virulent culture of *M. melitensis* direct from the spleen of a

guinea-pig, dead from *M. melitensis* septicæmia within 24 hours of intracerebral inoculation, is carefully emulsified in about 5 c.c. of sterile saline solution and transferred to the glass reservoir of an aseptic "laryngeal spray." By means of this little spraying apparatus the emulsion is evenly distributed over the surface of the "optimum" reaction (+8) agar contained in each of several culture bottles of either the Roux or the Kolle pattern. After insemination the culture bottles are incubated aerobically at 37° C. for from 24 to 36 hours. At the end of the incubation period the growth in the culture bottles is examined visually to determine its freedom from gross contamination; by means of stained preparations to determine its purity; and by the agglutination test with serum of high titre to determine its identity. The culture proving satisfactory, 5 c.c. of a 0·1-per-cent. saline solution are pipetted into each bottle, and by means of gentle agitation caused to take into suspension the upper layers of micrococci in the growth.

The turbid fluid is then pipetted off into a flask, which is labelled "A," and which receives in turn the surface washings from each of the culture bottles. A further 5 c.c. saline solution is introduced into the culture bottle, and the remainder of the growth is emulsified as evenly as possible with the help of a curved glass or platinum rod; this very turbid emulsion is transferred to a second flask labelled "B," containing a number of glass beads. When this process has been repeated with all the rest of the culture bottles and the emulsion added to that already in the flask with the beads, the flask with its contents is vigorously shaken at short intervals during the next half hour or so in order to disintegrate as far as possible any clumps of micrococci that may be present. The emulsion is then transferred to centrifugal tubes, placed in an electrical centrifuge, and run at a speed of some 2500 revolutions per minute for 30 minutes. At the end of this time a considerable deposit will have been thrown down, which is left behind in the tube, while the supernatant fluid is pipetted off and added to the surface washings from the culture bottles in the first flask. The centrifugal deposit is usually destroyed, but if a large quantity of vaccine is urgently required the deposit is returned to the flask "B," a few cubic centimetres of the saline solution added, and the shaking with the beads repeated. Further small quantities of saline solution are added from time to time during the process until an emulsion is formed which, to the naked eye, presents an opacity rather denser than that present in the emulsion in flask "A." This emulsion is again centrifugalised, and the supernatant fluid may be pipetted off and added to the emulsion in flask "A."

The emulsion in flask "A" is now ready for the enumeration of its contained micrococci, which is done by Wright's method if time is of supreme importance.

Wright's method consists of taking into a capillary Pasteur pipette, furnished with a rubber teat, three equal volumes of a solution containing 0·75-per-cent. sodium chloride and 1-per-cent. sodium citrate, one volume of normal blood direct from a needle puncture of the finger or ear (and assumed to contain 500 millions of red cells per cubic centimetre), and one similar volume of the emulsion of cocci. These various fluids are ejected from the pipette on to a slide and mixed thoroughly by repeatedly aspirating into and ejecting from the pipette; finally, the mixture is transferred to a clean slide, and with the help of a second slide a blood film is prepared in the usual way. This is stained by Jenner's or by Leishman's stain, and examined microscopically with a 1/12-inch objective; then by the enumeration of the red cells and of the micrococci respectively in a number of "fields" an average is struck for the ratio of the one to the other, and from this ratio is calculated the number of micrococci present per cubic centimetre of the emulsion.

Whenever possible it is desirable to control this method by ordinary plating methods—after such dilution of the emulsion as may be deemed necessary—incubating for three days at 37° C., and enumerating the resulting colonies by the help of a counting disc.

Whilst the enumeration is in progress the emulsion is distributed, in quantities of 10 c.c., in as many sterile test-tubes plugged with cotton-wool as may be necessary; the tubes are then suspended on a water bath running at 60° C., and allowed to remain there for half an hour from the time the water in the bath rose again to 60° C. after its temporary fall consequent upon the introduction of the tubes. At the end of this time the tubes are removed from the water bath and suspended in a bath of running water to cool them down rapidly. Next 0·1 c.c. of emulsion is removed from each of several tubes, and surface plate cultivations established from each sample in order to demonstrate the absence of living cocci from the emulsion. The tubes of crude vaccine are then protected by indiarubber caps slipped over the cotton-wool plugs, and set aside in the ice chest until the result of the enumeration is known.

Having measured the bulk of the crude vaccine and determined the number of cocci present per cubic centimetre, a very simple calculation decides the amount of diluent to be added to the emulsion to reduce the number of cocci present per cubic centimetre to, say, 1000 millions, which is, perhaps, the most useful standard. The diluent employed is a 0·1-per-cent. saline solution, the necessary quantity of which is measured out into a large flask, and to it is added tricresol in such amount that the finished vaccine shall contain 0·25 per cent. of the disinfectant, tricresol being employed in preference to phenol or lysol on account of its lack of irritating properties.

The crude vaccine is now transferred by means of sterile pipettes

from the tubes in which the emulsion was sterilised to the flask containing the diluent and antiseptic, in which thorough mixture is effected. This flask is next connected up to the side feed of a graduated burette, and the vaccine filled into glass bulbs in quantities of 0·5 and 1 c.c. as required, the bulbs sealed off, in the blow-pipe flame, and labelled, with a writing diamond, with some distinguishing character or number, which indicates the character and number of cocci in suspension inside the bulb.

The Inoculations: Time.—The inoculation was usually performed the last thing at night (10 P.M.), so that several hours' rest in bed intervened before the heavy work of the following day commenced. In many instances, however, 11 A.M. or noon was the hour at which the injection was made, but so far as could be ascertained, the time at which the inoculations were carried out exercised no influence upon the immediate clinical results.

Site.—The site of inoculation was the subcutaneous tissue of the abdominal wall just below the costal margin. The skin in this situation was prepared by thoroughly cleansing a small area with a 2-per-cent. solution of lysol applied with cotton-wool, then removing all trace of the antiseptic by directing a stream of ether from a drop bottle on to the spot, or swabbing it well with a pad of wool saturated with ether. The ether served a subsidiary purpose, in that by its rapid evaporation it cooled the prepared area of skin and reduced its sensibility.

Dose.—The inoculations were made with the help of a hypodermic needle attached to a 10 or 20 c.c. syringe, holding 20 or 40 doses respectively, as the bulk of inoculum was invariably 0·5 c.c. By using a large syringe supplied with a number of spare hypodermic needles, it was only necessary to replace the soiled needle by a fresh sterile one, after each inoculation, and proceed to the next individual, thus saving much valuable time when many men had to be inoculated.

The vaccine brought from England for the purpose of these inoculations was numerically stronger than usual, and contained 2500 million cocci per cubic centimetre, so that the number of organisms per dose could readily be varied by suitable dilution of the emulsion.

The initial dose varied slightly in individual cases, but was either two, three, or four hundred millions of cocci. Subsequent doses were regulated by the response of the individual to inoculation, as judged by the movements of the curve representing the agglutinin-titre of the serum, but were usually 400 millions of cocci.

After the hypodermic injection of the vaccine, a wisp of cotton-wool and a drop of flexile collodion sealed the needle puncture and supplied all the dressing necessary.

In many of the cases two inoculations were given at suitable intervals.

Sequelæ of Inoculations.—Before giving the details of the inoculations carried out, and their results, a few words are necessary as to the local and constitutional effects following the introduction of the dead bodies of *M. melitensis* into the subcutaneous tissue of the normal human subject, as observed in these 51 men.

Local Appearances.—The introduction of such a small quantity of fluid into the subcutaneous tissue produced no immediate effect other than a slightly marked prominence of the skin at the seat of inoculation. Usually the emulsion was completely absorbed within a few hours, and on the morning following the inoculation no local alteration was discernable. In three of the orderlies of the R.A.M.C., the first inoculation was followed by a very distinct, hard, tender lump at the seat of inoculation, the skin over the swelling being red and slightly œdematous. Some tenderness of the inguinal and axillary glands was present so long as the lumps remained tender, but this passed off rapidly when the swelling had disappeared. In all three cases the swelling subsided without interference, the duration of a visible tumour being limited to two or three days respectively in the first two cases. In the third, the lump, which was on the right side, remained visible and tender for seven days, and was probably due to the fact that the subject —an ardent cricketer—was on bowling for practically the whole of the afternoon following inoculation. Several of the Sick Berth Staff of the Bighi Hospital complained of pain at the site of the needle puncture after the first injection, but in each case this was found to be due to the pull of the shrinking collodion on the surrounding fine hairs and not to any alteration in the tissues at the point where the emulsion of cocci was deposited. Inoculations subsequent to the first failed to cause any discomfort. The inguinal glands in many were slightly tender for the 24 hours following an injection, but not longer.

Constitutional Symptoms.—Beyond slight headache and feeling of malaise, associated with a rise of temperature to 98°·6 F. or 99° F., complained of by a few on the day following inoculation, no constitutional symptoms were observed. Two of the controls, however, who had been injected with normal saline solution complained of severe headache and showed temperatures of 99°·6 F. and 99°·8 F. respectively on the day following the injection. It will thus be seen that none of the disquieting results recorded by Lieut. Bousfield, R.A.M.C.,* were noted in this series of inoculations. That they do occur, however, was well shown in the case of one of the members of the Working Party who was inoculated by Lieut.-Colonel Leishman immediately prior to leaving England. Marked enlargement, accompanied by tenderness on pressure of the superficial lymphatic glands was observed within 24 hours of inoculation, together with some headache and malaise.

* Bousfield, L, "Some Remarks on Protective Inoculation against Malta Fever," 'Journ. R.A.M.C.,' vol. 7, 1905, pp. 179—182.

Table XXXVIII.—Results of Inoculation with *M. melitensis* Vaccine, Royal Naval Hospital, Bighi.

No.	Number of times vaccinated.	Serum value before inoculation.	1st inoculation.		2nd inoculation.		Serum value (28/8/06) 4 months later.
			Dose of vaccine.	Agglutinin response.	Dose of vaccine.	Agglutinin response.	
1	1	nil	200	1 : 100 +	—	—	1 : 10 +
2	2	”	300	1 : 10 +	400	1 : 10 +	1 : 50 +
3	2	”	300	1 : 50 +	400	1 : 50 +	1 : 100 +
4	2	”	300	1 : 100 +	400	1 : 100 +	1 : 50 +
5	1	1 : 10 ±	200	1 : 100 +	—	—	nil
6	1	nil	200	1 : 100 +	—	—	1 : 5 +
7	2	”	200	1 : 50	400	1 : 100 +	1 : 10 +
8	2	”	200	nil	400	1 : 10 +	nil
9	2	”	200	1 : 100 +	400	1 : 200 +	1 : 10 ±
10	2	”	300	1 : 10 +	400	1 : 10 +	1 : 10 +
11	1	1 : 10 ±	200	1 : 200 +	—	—	1 : 10 +
12	2	nil	300	1 : 50 ±	400	1 : 10	1 : 25 +
13	2	1 : 10 ±	200	nil	400	nil	nil
14	2	nil	300	1 : 50 ±	400	1 : 10 +	1 : 5 ±
15	2	”	200	1 : 100 +	200	1 : 100 +	1 : 50 +
16	2	”	200	nil	400	1 : 100 +	1 : 5 +
17	2	”	300	1 : 50 +	400	1 : 50	1 : 25 +
18	2	”	300	1 : 10 +	400	1 : 10 +	1 : 10 +
19	1	”	300	1 : 100 ±	—	—	1 : 25 +
20	1	”	250	1 : 10 +	—	—	1 : 10 +
21	1	”	250	1 : 10 +	—	—	1 : 10 +

Table XXXIX.—Results of Inoculation with *M. melitensis* Vaccine, Royal Military Hospital, Valletta.

No.	Number of times vaccinated.	Serum value before inoculation.	1st inoculation.		2nd inoculation.		Serum value (28/8/06) 4 months later.
			Dose of vaccine.	Agglutinin response.	Dose of vaccine.	Agglutinin response.	
			millions.				
1	2	nil	200	nil	400	1 : 20 ±	nil
2	1	,,	400	1 : 100 +	—	—	—
3	2	,,	200	nil	400	1 : 10 +	1 : 10 ±
4	2	1 : 10 +	400	1 : 20 +	400	1 : 50 +	1 : 20 +
5	2	nil	400	1 : 20 +	400	1 : 20 +	1 : 10 +
6	1	,,	400	1 : 100 +	—	—	1 : 20 +
7	2	,,	200	nil	400	nil	nil
8	2	,,	200	nil	400	1 : 20 +	nil
9	2	1 : 10 +	200	1 : 20 +	400	1 : 20 +	1 : 50 +
10	1	nil	400	1 : 50 +	—	—	1 : 10 +
11	1	,,	400	1 : 50 +	—	—	1 : 10 +
12	1	,,	400	1 : 100 +	—	—	1 : 20 ±
13	2	,,	400	1 : 10 +	400	1 : 50 +	1 : 10 ±
14	1	,,	400	1 : 20 +	—	—	1 : 20 ±
15	2	,,	400	1 : 10 +	400	1 : 20 +	nil
16	1	,,	400	1 : 10 +	—	—	1 : 10 +
17	2	,,	400	1 : 20 ±	400	1 : 10 +	nil
18	1	,,	400	1 : 100 ±	—	—	nil
19	2	,,	400	1 : 10 +	400	1 : 100 ±	1 : 50 ±
20	2	,,	200	nil	400	1 : 20 +	nil
21	1	,,	400	1 : 50 +	—	—	1 : 20 +
22	1	,,	400	1 : 100 +	—	—	1 : 20 +
23	1	,,	400	1 : 50 +	—	—	1 : 20 ±
24	2	,,	200	1 : 10 ±	400	1 : 50 +	1 : 10 +
25	1	,,	400	1 : 10 +	—	—	1 : 10 +
26	2	,,	400	1 : 50 +	—	—	1 : 10 +
27	1	,,	400	1 : 20 ±	—	—	1 : 20 +
28	2	,,	200	1 : 20 +	400	1 : 50 ±	1 : 50 ±
29	1	,,	400	nil	—	—	nil
30	1	,,	400	1 : 20 +	—	—	1 : 20 ±

The seat of inoculation was occupied by a raised, hard, and tender lump, which gradually became soft and boggy to the touch, and the skin over it acquired a dusky-red colour. As there was every evidence of pointing, the tumour was incised on the 11th day and some thin serous pus, which proved sterile, was evacuated; and no higher dilution of the blood serum than 1 in 10 would give a positive agglutination reaction.

Later on an injection of the same brew of vaccine that was used in the series of prophylactic vaccinations now under consideration was introduced into the opposite flank. This was followed by a precisely similar train of events, although on this occasion the symptoms were distinctly less severe: the agglutination response on this occasion rose to 1 in 40.

Returning once more to the series of inoculations carried out upon men of the Naval Hospital and of the R.A.M.C. it must be noted that the response of the individual as judged by the movements of the agglutination value of the serum varied within wide limits from a positive reaction in a dilution of 1 in 200 to a negative reaction in a dilution of 1 in 5 as a result of the first injection.

A further point to be noted in the tabulated details is the very distinct fall in the titre of the serum that has taken place by the end of the four months, in one case from 1 in 200 to 1 in 10, showing that the individual response to vaccination, so far as relates to the production of antibodies of the agglutinin group at any rate, is limited to a comparatively short period, and apparently indicates that a further inoculation is necessary at the end of about three months after the first or second.

The immunity of the inoculated men during a period of four months from any attack of Malta Fever, though possibly due in part to the elimination of the "goat's-milk" factor, points to the necessity of a further trial of the *M. melitensis* vaccine—on a large scale; and in this case it would be of advantage to inoculate a large body of men, say half a regiment, before they enter the endemic area and then again after some three months' service in Malta.

VIII. Clinical Observations.

The limited time at the disposal of those members of the Working Party who were engaged in the Bacteriological and Experimental Investigation, no less than the paucity of cases occurring during the summer of 1906, precluded any extensive observations being carried out in connection with the clinical side of Malta Fever as it occurs in man. Certain points were, however, enquired into, and the results obtained are inserted here rather as indications of lines of research requiring further elucidation, than as dogmatic statements from which definite conclusions can be drawn.

Under these circumstances a bald outline of the observations made and the results obtained are all that are necessary, and these may be arranged under separate headings for convenience of reference.

(a) *Blood.—Presence of Micrococci therein.*—The presence and multiplication of *M. melitensis* in the blood of Malta Fever patients at various stages of the disease is now an established fact and fixes the position of the infection as a definite and specific septicæmia, though the researches of Gilmour and Shaw appear to indicate that the number of cocci present per cubic centimetre in the peripheral blood is usually small. A consideration of the work of these observers, however, led to the conclusion that if cases in the very early stages of the disease, at or near the summit of a period of pyrexia, were selected for observation and blood collected late in the day, relatively more organisms would be found than had hitherto been noted. A careful scrutiny of the case notifications enabled three cases to be eventually selected as especially suitable, and one observation was made on each patient.

The technique of the blood collection was that usually employed in hospital work in England; that is to say, the forearm was carefully washed, lathered with soft soap and shaved, then washed with lysol (2-per-cent. solution) and finally cleansed with ether, and a bandage was bound tightly about the arm above the bend of the elbow. The interior of a 5-c.c. all-glass syringe was next moistened with 10-per-cent. solution of sodium citrate in normal saline by first filling and then emptying the barrel; the object, of course, being to prevent any alteration in the physical condition of the collected blood, such as general or local clotting, between the moment of filling the syringe and of transferring the blood to the nutrient medium. The needle was then thrust into the lumen of either the median basilic or median cephalic vein and the syringe itself depressed and allowed to fill with blood as the piston was gradually withdrawn by gravity.

A series of test-tubes filled with accurately measured quantities of nutrient broth had previously been arranged in a test-tube rack. One cubic centimetre of the blood was then added to 9 c.c. of nutrient broth in the first test-tube and thoroughly mixed—this tube was labelled No. I. From Tube No. I, 0·1 c.c. of the mixed blood and broth was removed by a sterile graduated pipette and added to 9·9 c.c. broth in Tube No. II; 0·1 c.c. of the contents of Tube No. II were then added to 9·9 c.c. broth in Tube No. III. Next 1 c.c. of the contents of Tube No. I was added to a fresh tube of broth labelled Tube *1*: then 0·1 c.c. from Tube No. I was added to another tube of broth numbered Tube *2*. This process was then repeated with the two other tubes marked with Roman numerals, the Arabic figures *3*, *4*, *5*, and *6* being employed to distinguish the secondary tubes inoculated therefrom.

Thus a series of dilutions was obtained as under:—

		Cubic centimetres of blood.
Tube I	contained	1 (approximately)
„ *1*	„	0·1
„ *2*	„	0·01
„ *3*	„	0·001
„ *4*	„	0·0001
„ *5*	„	0·00001
„ *6*	„	0·000001

while Tubes Nos. II and III served as controls to Tubes *2* and *4* respectively.

Finally the 4 c.c. of blood remaining in the syringe were distributed amongst several tubes of broth to guard against the possibility of total failure to obtain a growth, which might otherwise happen if only a few cocci were present in the blood collected.

All the tubes were then incubated at 37° C. for preliminary enrichment, and on and after the third day plates were inseminated with broth from such of the tubes as showed naked eye growth.

Then by noting the tube containing the smallest quantity of blood from which the micro-organism was recovered it became an easy matter to calculate the number of cocci present per cubic centimetre in the peripheral blood of the patient.

By following this procedure the coccus was found to be present in all three cases in fairly large numbers. The following are the details of these cases:—

1. Private Kirton—onset of disease, 18.6.06: admitted to hospital, 21.6.06. Blood collected, 25.6.06 at 7 P.M. Serum agglutination value—1 in 2000. *M. melitensis* present to the number of at least 1900 per cubic centimetre.
2. Private Fitzgibbon—onset of disease, 28.5.06: admitted, 31.5.06. Blood collected, 5.7.06 at 7 P.M. Serum value—1 in 200. *M. melitensis* present to the number of 10,000 (but not 100,000) per cubic centimetre.
3. Private Kearney—onset of disease, 20.5.06: admitted, 23.5.06. Blood collected, 5.7.06, at 7.30 P.M. Serum value—1 in 200. *M. melitensis* present to the number of 1000 (but not 10,000) per cubic centimetre.

2. *Leucocyte Formula.*—The work of the French observers in Tunis—Hayat, Cathoire, Cardaliguet, Schoull, etc.—tends to show that the leucocyte formula of the blood in Malta Fever cases presents a consistent variation from the normal, and to this variation is attached diagnostic importance. The variation is stated to be in the direction of a relative and often an absolute increase in non-granular cells; and the few

Table XL.—Blood Counts in Malta Fever.

Name.	Date of admission.	Type of case.	Date of blood examination.	Serum value.	Red cells per cubic millimetre.	Hæmoglobin.	Cell index.	White cells per cubic millimetre.	Differential count of white cells per centum. Small lymphocytes.	Large lymphocytes.	Large hyaline mononuclear cells.	Polymorphonuclear neutrophiles.	Eosinophiles.	Mast cells.	Total non-granular cells.	Total granular cells.
Serg.-Maj. A.	30/6/06	Mild	27/7/06	1 : 500,000	4,870,000	p.c. 90	0·92	7600	47·6	3·6	8·4	45·0	0·0	0·4	54·6	45·4
Staff-Serg. B.	2/6/06	Severe	26/7/06	1 : 50	5,100,000	59	0·57	9000	19·8	2·4	5·0	70·0	2·2	0·6	27·2	72·8
Pte. K..........	2/6/06	Severe	26/7/06	1 : 2,000	4,670,000	68	0·72	7000	44·2	3·6	1·2	48·0	3·0	0·0	49·0	51·0
Rifleman J....	11/7/06	Mild	26/7/06	1 : 20	4,970,000	79	0·79	7000	42·8	3·6	2·0	50·2	0·6	0·8	48·4	51·6
	Normals	....	—	Nil	5,000,000	100	1·00	7500	24		5·0	70·0	0·5—1	?	29·0	71·0

observations made during the summer on this point afford some confirmation of these statements.

In four cases a complete blood examination was carried out, the red and white cells being enumerated by the aid of the Thoma Zeiss hæmatocytometer, the hæmoglobin estimated in a Gower's hæmoglobinometer, and a differential leucocyte count, made on films, stained by Jenner's method—the classification adopted under the last heading being that advocated by Price-Jones,* to whom we are greatly indebted for confirming the accuracy of the counts. The results obtained are tabulated in Table XL, from which it will be seen that in three there was a very marked rise in the non-granular cell-content of the blood. In the fourth the deviation from normal was only noticeable in the deficiency of hæmoglobin.

(b) *Milk.*—Although, arguing from analogy, it was a foregone conclusion that *M. melitensis* would be found in human milk, actual demonstration had hitherto been wanting on account of the infrequency of lactation being associated with Malta Fever. During the summer of 1906 opportunity was afforded of investigating three cases only, but from two of these the micrococcus was recovered.

In collecting specimens of the milk, the breast was first washed up with soap and water, then with ether, then the bell opening of a sterile glass breast pump was applied and the milk received in the side bulb. Details of the successful recoveries are as follows:—

Mrs. A., Military Family Hospital, Valletta. Onset of disease, 7.5.06. Date of delivery, 24.6.06. The flow of milk was scanty from the first and the mother was unable to suckle her infant, which was consequently hand-fed on condensed milk. A sample of milk was collected from the right breast 26.6.06. The milk, which was yellowish in colour and distinctly oily, gave a complete agglutination reaction in dilution of 1 in 100. Single drops (about 0·03 c.c.) were used to inseminate each of about a dozen plates, which after incubation yielded about half-a-dozen colonies of *M. melitensis* per plate, so that each cubic centimetre of milk contained about a couple of hundred micrococci. A second sample of milk collected 5.7.06, required the exercise of powerful suction before even a couple of cubic centimetres could be obtained. The agglutination reaction was now obtainable in dilution of 1 in 2000, and *M. melitensis* was present to the number of some 300 per cubic centimetre.

C. G., Misida. Attack of Malta Fever, September—December, 1904, during the puerperium. The milk practically dried up and the child was hand-fed. Eighteen months later (June, 1906) patient

* Jones. C. Price, 'Brit. Med. Journ.,' 1905, vol. 1, pp. 409, 410; 1905, vol. 2, pp. 1112, 1113.

Table XLI.—*M. melitensis* in Urine of Ambulatory Cases.

Date of plating.	1857. B. Worley.		3414. F. Mallia.	
	Treatment.	Number of colonies of *M. melitensis* per c.c.	Treatment.	Number of colonies of *M. melitensis* per c.c.
April 20	nil	440	Daily from 27/4/06 to 1/6/06 peroxide of succinic acid 2 grs. p. aq. dist. ad. ℥ x.	9,000
" 24	"	1,800		2,000
" 27	"	720		12,000
May 1	"	3,000		21,000
" 4	"	185		300
" 8	"	2,350		10,500
" 11	"	1,800		12,000
" 15	"	1,000		∞
" 18	"	1,060		600
" 22	"	860		600
" 25	"	1,900		950
" 29	"	∞		1,500
June 1	"	∞		∞
		on leave		
" 12	"	40	nil	nil
" 15	"	2,140	"	"
" 19	"	180	"	"
" 22	"	10	"	"
" 26	"	150	"	"
" 29	"	240	"	"
July 3	"	1,068	"	"
" 6	"	3,890	"	"
" 20	"	110	"	"
" 24	"	2,555	"	"
" 27	"	1,020	"	"
" 31	"	2,210	"	"
Aug. 1—14	Daily from 18/8/06 to 31/8/06 peroxide of succinic acid, as Mallia	not enumerated, but *M. melitensis* constantly present	nil	nil
" 21 ...		500	"	"
" 24 ...		1,242	"	"
" 28 ...		28	"	"
" 31 ...		301	"	"
Sept. 4	nil	705	"	"
" 7	"	6,300	"	"
" 11	"	24,140	"	no sample
" 14	"	14,000	"	nil
" 18	"	3,500	"	"
" 21	"	2,650	"	"
" 25	"	6,715	"	"
" 28	"	7,600	"	"

∞ = innumerable.

states that flow of milk has never entirely ceased—small quantities can still be squeezed from the gland. A sample of a couple of cubic centimetres collected in the sterile breast pump by the aid of a combination of suction and expression on three several occasions. The milk, which appeared normal in colour and consistence, gave a positive reaction in dilution of 1 in 200. Plate cultivations to the number of three were prepared, each with 0·5 c.c. of the milk at each examination. At the first and third *M. melitensis* could not be detected in the resulting growth, but at the second examination saprophytes were practically absent, and colonies of *M. melitensis* to the average number of 25 were present in each of the three plates, *i.e.*, average 50 per cubic centimetre.

(c) *Urine.*—The two cases of Ambulatory Malta Fever in workmen in R.N. Dockyard handed over by Staff-Surgeon Shaw, R.N., when he left Malta,* were kept under observation during the summer.

No. 3414, F. Mallia, was treated from 24.4.06 to 1.6.06 with peroxide of succinic acid in the form of a 1 in 10,000 solution, 5 ounces of the solution being administered morning and evening, and by June 15 the *M. melitensis* had disappeared from the urine.

No. 1857, B. Worley, who served as a control to the previous case whilst peroxide was being administered, continued to pass urine containing large numbers of *M. melitensis* until October, when the examination of his urine was discontinued, although he, too, had been put on the peroxide in similar doses for a fortnight from 18.8.06 to 31.8.06.

(d) *Fæces.*—Only one or two observations were made with a view to the detection of *M. melitensis* in the fæces. The results so far as concerned firm, formed motions, were negative, but in one fatal case (Private R.) of one and a-half months' duration, where the intestines were filled with light semi-fluid fæces, the presence of *M. melitensis* in considerable numbers was demonstrated after plating on ox serum nutrose agar.†

(e) *Post-mortem Examinations.*—But two fatal cases of Malta Fever occurred during the first eight months of 1906 in the R.M. Hospital, Valletta, upon which *post-mortem* examinations were held. The details of these are here tabulated.

Several *post mortems* (which were witnessed by the courtesy of the staff of the Civil Hospital) were conducted on fatal cases of Malta Fever, but in these systematic bacteriological investigations were not carried out.

* See these Reports, IV, p. 12 and V, p. 40.

† Eyre, J. W. H., "The Preparation of Nutrose Agar," 'Trans. Path. Soc.,' vol. 55, 1904, pp. 91--105.

Table XLII.—*Post-mortem* Details.

Organ or tissue examined.	Pte. D. 27/1/06.	Pte. R. 31/5/06.
Heart blood	*M. melitensis* present	*M. melitensis* present
Pericardial fluid	not examined	"
Spleen	*M. melitensis* present	"
Bile	not examined	"
Inguinal glands	"	"
Mediastinal glands	"	absent
Mesenteric glands	*M. melitensis* present	*M. melitensis* present
Salivary glands	"	not examined
Thyroid glands	"	"
Suprarenal glands	"	"
Pancreas	"	"
Fæces	not examined	*M. melitensis* present

IX. *Conclusions.*

It must be noted that, in addition to breaking new ground, much of the experimental work of the Mediterranean Fever Commission during the summer of 1906 has necessarily been arranged in order to elucidate the previous work of individual members and to collate the recorded facts; and from a general review of the whole question of *M. melitensis* infection in man, and in the light of our present knowledge, it may be fairly stated that—

(*a*) The most common method of infection is by the ingestion of infective articles of food—mainly milk.

(*b*) The next common path of infection is by subcutaneous inoculation during the handling of infective material—usually milk.

(*c*) More rarely infection may occur as the result of contagion, or, possibly, through convection by means of blood-sucking insects.

The results obtained by the Working Party during the summer of 1906 have been summarised in the foregoing pages in connection with the headings to which they relate; the more obvious and the more important of the conclusions arrived at are here recapitulated:—

1. The goat is highly susceptible to infection by *M. melitensis* as the result of cutaneous, subcutaneous, intravenous, and intraperitoneal inoculation, and as the result of feeding with infective material.

2. The course of the resulting septicæmia is extremely mild, and usually after the first few days cannot be demonstrated by clinical observation.

3. In order to detect *all* the infected milch goats in any given herd it is necessary to repeatedly examine the milk at short intervals. In selecting milks for bacteriological examination a positive milk agglutination reaction (Zammit's test) is a much more reliable indication

of the presence of *M. melitensis* than is a positive serum agglutination test.

4. During the course of the infection the *M. melitensis* first disappears from the peripheral blood and from most of the viscera, next from the spleen and kidneys, next from the superficial lymphatic glands, and last of all from the mammary gland.

5. The appearance of *M. melitensis* in the milk of the goat is a comparatively late phenomenon; the coccus present in this fluid is fully virulent, and the milk itself highly infective. The number of *M. melitensis* in the milk varies within wide limits from day to day, and bears no relationship to the severity of the infection, air temperature, etc.; the presence of *M. melitensis* in the milk appears to be merely the result of a mechanical flushing of the mammary gland by means of which the cocci multiplying therein are removed.

6. *M. melitensis* is not destroyed during the processes incident upon the manufacture of the ordinary ice-creams, or of the native cheeses, and may be present in the retail articles living and unaltered in virulence.

7. The association of infected milch goats in a herd with cases of Malta Fever in the owner's family (the members of which do not as a rule partake of the milk) suggests the frequency of cutaneous inoculation through scratches and abrasions of the human skin.

8. The administration by the mouth of infective goats' milk is usually followed in the monkey by an attack of *M. melitensis* septicæmia, 83 per cent. of the experimental animals yielding absolute and conclusive evidence *post mortem* of the existence of *M. melitensis* septicæmia, irrespective of the dose of infective bacteria.

9. The eight members of the crew of the "Joshua Nicholson," and one woman in the United States developed Malta Fever after the ingestion of infected milk under conditions which point to the absence of other sources of infection.

10. Weak solutions of hydrochloric acid exert some slight bactericidal power on *M. melitensis in vitro*, which becomes more marked when pepsin is also present in the solution. The introduction of infective milk directly into the stomach was not, in the two experiments made, followed by *M. melitensis* infection.

11. The mosquito (Acartomyia and Stegomyia) and the common blood-sucking fly (Stomoxys) can act as the host of *M. melitensis* for a short period, generally limited to four or five days, and during that time the bacterium retains its virulence unimpaired.

12. *M. melitensis* can exist for many days in, and be recovered in a virulent condition from, the "droppings" of these insects.

13. One only out of a number of experimental animals (in 14 of which exact data are available) showed signs *post mortem* of a mild

infection by *M. melitensis*, subsequently to being bitten by highly infective mosquitoes.

14. The existence of *M. melitensis* in urine and vaginal swabbings of infected females, together with the successful inoculation of experimental monkeys through the mucous membrane of the glans penis, points to the possibility of infection in man during sexual congress.

15. The inoculation of *M. melitensis* vaccine in the normal man is but rarely followed by any marked local or constitutional disturbance.

16. The prophylactic use of one or two doses of such vaccine in some 60 cases appears to have afforded protection for a period of about four months, and suggests the necessity of repeating this observation on a large scale—the first treatment to be carried out prior to the entrance of the men into the endemic area.

17. The therapeutic use of *M. melitensis* vaccine appears likely to become a valuable method in the treatment of the infected milch goats.

18. The few clinical observations that were made by the Bacteriological Section of the Working Party :—

(1) Demonstrated the presence of *M. melitensis* in human milk and fæces.

(2) Indicated the necessity for further investigation into the "leucocyte formula" in blood of Malta Fever cases in view of possible variations therein affording useful aid in diagnosis; and also for further investigation into the phenomenon of the passage of *M. melitensis* in the urine with a view to the selection of one or more urinary germicides capable of destroying the cocci in the genito-urinary tract.

Recommendations as to Preventive Measures in Connection with Mediterranean Fever in Malta.

Various suggestions for the prosecution of a campaign against Mediterranean Fever arise from a consideration of the bacteriological and experimental data detailed in the Report of the work of the Mediterranean Fever Commission during 1906.

These fall naturally into one of two broad groups which, for our present convenience, may be designated by the titles of "palliation" and "eradication" respectively, and deal with the measures which must necessarily be adopted according to whether we merely wish to relieve our Navy and Army of the disastrous effects inseparable from the incidence of the disease, or to attempt the stamping out of Malta Fever from a dependency of the Crown which has, in the past, been considered of some strategic importance.

The first point to which attention should be directed, no matter what preventive measures are ultimately instituted, is the provision of an efficient and thorough system of compulsory notification of Mediterranean Fever. The system should probably be introduced in the form of an "Ordinance," and modelled on the lines of that at present in force in the British Isles under the Infectious Diseases (Notification) Act, 1889, and should be organised from a Central Office to which all notifications—naval and military as well as civil—should be sent. Provision should be made for the payment through the Public Health Department of fees (which in this instance need not exceed 6*d.* per notification) to civil practitioners in attendance on cases of Mediterranean Fever, and, on the other hand, for penalties for such as wilfully disregard the enactments of the Ordinance.

Palliation.—Reviewing the evidence already collected by the Mediterranean Fever Commission in its entirety, it is fairly obvious that the infective character of the milk of many of the goats upon the island of Malta affords a ready and reasonable explanation of the means by which the disease is transmitted. Then, too, the evidence yielded by experiments upon monkeys, supported by the facts of the s.s. "Joshua Nicholson" epidemic, justifies the assumption that in the ingestion of infected milk we have the veritable infective agency in the vast majority of cases. Additional weight attaches to this view by reason of the declining case incidence that was associated with the compulsory substitution (owing to the goatherds' strike) of imported preserved milks for the fresh goats' milk by the local naval and military authorities. Consequently, the strict prohibition of the use of the local supplies of fresh milk by the garrison and fleet should result in a very large diminution of the wastage from Malta Fever, and is a preliminary measure which must be enforced

during the period that will necessarily elapse before the existing supply of virus is appreciably influenced by the measures to be suggested with a view to the eradication of the disease. Whether or no the time is yet ripe for the State supervision of the milk supplies, the erection of depôts, constructed upon sanitary principles, for the milking of goats and other animals, and the subsequent distribution of the milk, is an open question; but in any case the liberty of the goat to perambulate the streets of Valletta and other large towns, to feed from the garbage of the gutter, and to pollute the atmosphere, must be curtailed to the extent of prohibiting the entry of the animals into the fortified cities and barrack squares, if only to increase the effectiveness of regulations based upon the above recommendations.

Eradication.—The measures to be adopted under the preceding heading are comparatively simple, and when dealing with a disciplined body of men, such as compose our Navy and Army, fairly easily enforced. Measures for the stamping out of the disease, on the other hand, which have to be applied to the goat and other milk-yielding animals through the intermediary of the owner, must needs bring the sanitary authorities into conflict with the usually uneducated and often violently prejudiced native of the agricultural class, and it is uncertain how far recommendations under this head will, from the diplomatic point of view, commend themselves to the civil authorities. In the event of any or all such recommendations being adopted, the Ordinance upon which they are based will need to be administered with great firmness and tact.

In the first place, it is essential that all the goats in the island should be registered, and some method should be employed of numbering by means of stamped metal discs (such as is already carried out in the case of dogs), which will afford a ready means of identification of individual animals. Next, repeated analyses of samples of milk, taken at regular intervals, must be made in respect to every milch goat by medical officers of health (who need not be bacteriological experts) specially detailed for this purpose, at three, four, or more district "centres," where laboratories for the application of the Zammit milk test must be provided. Further, samples of the milk from each animal, giving a positive reaction with this test, must then be sent to the Central Laboratory in the Public Health Department at Valletta for bacteriological examination for the demonstration of the presence of *M. melitensis.* So far the suggested measures are simple in theory, and by no means costly in practice; nevertheless, unless carefully handled, the Maltese goatherd will offer considerable opposition to their execution.

The remaining measures deal with the segregation of such infected animals as are found from time to time to be yielding milk containing

the specific micro-organism of Mediterranean Fever, and will necessarily be more expensive in operation, though, considering the importance of the issue at stake, not unduly so.

The total number of goats to be dealt with amounts approximately to 20,000, of which probably at least 2000 are infective, so that provision should be made on a liberal basis for dealing with possibly 5000 animals during the first year's work. When an animal is definitely shown to be yielding infective milk, it should be at once seized by the sanitary authorities and transferred to the Lazzaretto, or some other "pound" to be subsequently established, the owner being compensated on a scale comparable to that employed in Great Britain when infective animals (*e.g.*, in pleuro-pneumonia, tuberculosis, etc.) are seized by the public health authorities, and the milk stall should be disinfected and lime-washed. As, however, the flesh of infected goats, etc., is harmless when cooked, considerably more than half of the animals thus seized could be slaughtered, the viscera destroyed, and the flesh sold for consumption—a proceeding which would materially lighten the cost of these preventive measures. Moreover, as the progeny of infected milch goats is itself uninfected at birth, the seizure and destruction of infected animals should be combined in the case of the more valuable animals—the specially good milkers, etc.—with a modification of the "Bang process" for the reproduction of tuberculous herds, under the direct control of the Public Health Department, at special breeding farms where the selective in-breeding, which has rendered the Maltese milch goat such a valuable animal, could be continued under skilled supervision. This process, devised by Professor Bang, of the Copenhagen Veterinary College, as applied to tuberculous herds, has already been carried out with marked success in Denmark, Hungary, and the United States of America, and it appears probable that in dealing with the *M. melitensis* infection in goat the whole of the infective animals thus seized would be the replaced by healthy animals in the course of three or four years. Here, again, by the sale of yearlings a considerable return might be effected. While the capital sum required to organise and carry out all these measures in an efficient manner is greater than the civil authorities in Malta could readily devote to the purpose, the enormous saving in fighting material that would accrue to the Navy, and particularly to the Army, by the disappearance of Mediterranean Fever from the Maltese Islands, would amply justify an appeal to the Imperial Exchequer—assuming, of course, that Malta retains its present importance as a base for our sea and land forces.

Although, as is indicated later, certain powers are available already under Ordinance III of 1904, it would probably be preferable to introduce a new Ordinance for the purpose of stamping out Mediterranean Fever from the goats of the Maltese Islands, under the title of Infectious Diseases (Mediterranean Fever) Ordinance of 1907.

The various suggestions embodied in the foregoing paragraphs are here summarised.

Regulations for the Prevention of Mediterranean Fever.

I. *General.*

1. Compulsory notification enforced under an Ordinance which provides fees for compliance with, and penalties for disregard of, its provisions.
2. Popular education with regard to disinfection of excreta of patients suffering from Mediterranean Fever.
3. Prohibition, by Ordinance, of exportation (or importation) of goats, cows, ewes, asses, or other animals yielding milk for domestic purposes, which are the subjects of *M. melitensis* infection.
4. Prohibition of the entry of goats into Valletta and fortified cities, and into barrack squares, etc.

II. *Palliation.*

1. Popular education with regard to the infective character of the milk from certain animals with instructions as to boiling the fluid to destroy its noxious character; also with regard to the infective nature of milk products from such animals (*e.g.*, cheese, ice-cream).
2. Absolute prohibition, by orders from the Admiral commanding the Mediterranean Fleet and the officer commanding the land forces, of the purchase and consumption of native fresh milk (or of milk products, such as cheese, ice-cream, etc., prepared from native milk) by either officers or men, provision being made for definite penalties in the event of disobedience.
3. The official supply, by importation, of a sufficiency of reliable brands of preserved and condensed milks to the naval, military, and civil hospitals, and to the various canteens and messes.

III. *Eradication.*

1. Compulsory registration (by Ordinance) of every owner of one or more goats, cows, ewes, milch asses, etc., whether kept for the purpose of trade or otherwise, and of every breeder of such animals, and the granting of a metal badge bearing a specific sign or number for each animal, such badge to be securely attached to the animal to which it has been assigned, provision being made for the imposition of penalties for disregard or evasion of the enactments of this Ordinance.
2. Strict enforcement of Ordinance No. III of 1904, Cap. II, Section 5, Articles 79, 82, 83, and of the penalties referred to in Cap. IV, Articles 161 165, 174 (by Ordinance).

3. The interpolation of the words "milch goat, milch ass, ewe, or other animal yielding milk for domestic purposes" after the words "milch cow," in every article of the Fifth Section of Ordinance No. III of 1904, where such words are needed to apply the provisions of the article to animals other than the milch cow; also the interpolation of "Mediterranean Fever" into Article 91 (*b*), specifying certain infective diseases of animals; also the interpolation of the words "Mediterranean Fever" after the words "tuberculous disease" in Article 93, specifying powers of entry by sanitary officials, and of the words "or ice-creams" into Article 100 (2), specifying milk products to which the article is applicable.

4. The establishment of small laboratories with an adjoining compound, equipped for the performance of the "Zammit" milk test and the segregation of infected animals in such districts as Zeitun, Zurrik, Gargur, Notabile, and Mellieha in Malta and Victoria in Gozo, each under the charge of a specially detailed medical officer of health, assisted by a sanitary inspector; the function of each district laboratory being to examine once in every two weeks a sample of milk from each milch goat, etc., within its district; to seize, to segregate, and to report to the Public Health Department such animals as yield a positive reaction, and to forward specimens of their milk for bacteriological examination, and on the removal of infected animals to supervise the disinfection, etc., of the premises from which the seizure has been made.

5. On completion of proof that suspected animals are infected and infective, the Public Health Department shall seize such animals and dispose of them, either by slaughter and sale in the public abattoir, or otherwise, and compensate the owner according to a fixed scale to be subsequently determined.

6. In the case of valuable animals, good milkers and in good condition, the owner shall be compensated as in 5, and the animals retained alive for breeding purposes at an experimental station situated, say, at Ghain Tuffieha.

7. Immediately after the birth the offspring of infected dams shall be removed and subsequently fed on milk from healthy animals or on Pasteurised milk from infected animals.

8. As the infected animals are replaced by healthy ones they may be fattened up, slaughtered at the public abattoir, and the flesh sold.

9. Finally, experimental treatment by *M. melitensis* vaccine, on the lines indicated in this Report, should be carried out on a large scale, and its potentialities estimated.

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REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART VII.

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INTRODUCTION.

In the introductions to Parts I and III the history of this investigation was related from its commencement in June, 1904, until July, 1905.

The Commission appointed to continue the work during the summer of 1905 consisted of Lieut.-Colonel A. M. Davies, R.A.M.C., Major W. H. Horrocks, R.A.M.C., Staff-Surgeon E. A. Shaw, R.N., Dr. T. Zammit, Board of Health, Malta, and Captain J. Crawford Kennedy, R.A.M.C.

Lieut.-Colonel Davies left Malta for England on September 24, and Major Horrocks for Gibraltar on October 14, 1905, while Messrs. Shaw, Zammit, and Kennedy continued the investigation during the following winter. The results of the work of the Commission during 1905 are published in Parts III, IV, and V.

At a meeting of the Mediterranean Fever Sub-Committee held on February 25, 1906, it was decided to continue the work during the ensuing summer, and, as Messrs. Davies, Horrocks, and Shaw would not be available, that Major T. McCulloch, R.A.M.C., Major J. C. Weir, R.A.M.C., Major J. G. McNaught, R.A.M.C., Staff-Surgeon F. H. A. Clayton, R.N., and Dr. J. W. H. Eyre, M.D., Bacteriologist to Guy's Hospital, be appointed to the Commission in addition to Captain Kennedy and Dr. Zammit.

Colonel D. Bruce, R.A.M.C., Chairman of the Sub-Committee, was also requested to proceed to Malta to introduce the new members to the work. He arrived in Malta on April 14, 1906, and work was at once begun on the lines laid down by the Sub-Committee in their memorandum dated February 23, 1906. He left for England on May 5.

Dr. Eyre and Major McNaught remained in Malta until September 2, and Staff-Surgeon Clayton, Majors McCulloch and Weir, and Captain Kennedy until the end of that month.

The work done in the summer of 1906 is embodied in Parts V, VI, and VII:—

Part VI.—"Report upon the Bacteriological and Experimental Investigations during the Summer of 1906," by J. W. H. Eyre, M.D., Major J. G. McNaught, R.A.M.C., Captain J. C. Kennedy, R.A.M.C., and Dr. T. Zammit.

Part VII.—"Epidemiological Work in 1906: (*a*) Naval," by Staff-Surgeon F. H. A. Clayton, R.N.; "(*b*) Military and Civil," by Majors T. McCulloch and J. C. Weir, R.A.M.C.

The Bacteriological Report (Part VI) discusses infection by goats' milk, conveyance by mosquitoes and other blood-sucking insects, infection by contact, prophylactic vaccination, and clinical observations. Dr. Eyre and his colleagues sum up their results by saying that the ingestion of infective articles of food, mainly milk, is the most common path of infection by *Micrococcus melitensis* in man; that the next common path of infection is by subcutaneous inoculation during the handling of infective material, usually milk, and that more rarely infection may occur as the result of contagion, or possibly through convection by means of blood-sucking insects.

The Epidemiological Reports (Part VII) go fully into the occurrence of cases of Mediterranean Fever in ships, barracks, and hospitals, with statistics relating to the incidence among various classes, effect of age and sex, residence, climatic conditions, etc., and also give a detailed account of the result of preventive measures instituted in the middle of 1906.

The epidemiologists are led to believe that quite 70 per cent. of the cases are due to the ingestion of goats' milk. They also believe that it is probable that the disease is acquired through infected milk, or, less often, urine, coming in contact with breaches of the surface, and so inoculating the disease. In their opinion, ordinary contact with the sick, conveyance of infection by biting insects, house-flies, dust, drain emanations, food (other than milk), and water play a very subordinate part, if any, in setting up Mediterranean Fever in man.

The excellent results following the preventive measures directed against the use of goats' milk in barracks and hospitals also point to milk being the chief factor.

Among the soldiers this resulted in a diminution of about 90 per cent. For example, in the second half of 1905 there were 363 cases of Mediterranean Fever, whereas in the corresponding part of 1906 there were only 35 cases. Among the sailors there was also as marked a fall in the number of cases. Very remarkable is the history given by Staff-Surgeon Clayton in regard to the Naval Hospital at Malta. This building had a bad reputation, as one-third of the cases of fever occurring in the fleet at Malta could be traced to residence in this hospital, either as patients suffering from other diseases or among the nursing staff. The goats supplying the hospital with milk were examined, and some 10 per cent. of them were found to be passing *Micrococcus melitensis* in their milk. About the end of June goats' milk was forbidden, and since then not a single case of Mediterranean Fever has occurred in, or been traced to residence in, this hospital.

Taking all the facts and arguments into consideration, it would appear that this Commission has been successful in discovering the main source of infection of Mediterranean Fever. This source is the Maltese goats, some 20,000 in number, half of which are affected by

Mediterranean Fever, and one-tenth are constantly passing the parasite of this disease in their milk. If this source of infection is removed, in all probability the fever will disappear completely from Malta.

The special thanks of the Commission are due to His Excellency the Governor; the Lieutenant-Governor; Lord C. Beresford, Naval Commander-in-Chief; Colonel Winter, A.S.C.; Colonel J. G. MacNeece, R.A.M.C., P.M.O., Malta; Lieut.-Colonel J. H. Rhodes, R.A.M.C.; Lieut.-Colonel R. Jennings, R.A.M.C.; Major G. S. Crawford, R.A.M.C.; and Captain E. Ryan, R.A.M.C.; and the officers of the Royal Army Medical Corps generally; Deputy-Inspector-General Bentham, R.N., and officers, Bighi; the Hon. L. Gatt, C.M.G.; the Hon. Sir R. Micallef, K.C.M.G., the Governor, Detention Barracks; Mr. A. M. MacFarlane, Government Veterinary Surgeon; Professor Samut and Dr. Portelli Carbone, of the Civil Hospital; Dr. Caruana Scicluna, and Dr. A. Critien, Board of Health; Drs. Said and Rutter, of the Government Medical Service; Mr. T. Curmi, Superintendent of Police; the Superintendent of the Civil Hospital; Mr. Grout, of the American Consular Service; Fleet-Surgeon Hardie, of H.M. Dockyard; Professor Magro and Cyril Leach, Esq., of the Meteorological Department, University of Malta.

EPIDEMIOLOGICAL WORK IN 1906.

By Major T. McCulloch, M.B., Major J. C. Weir, M.B., Royal Army Medical Corps, and Staff Surgeon F. H. A. Clayton, M.D., Royal Navy.

(Received 25th January, 1907.)

Introductory.

As the result of a recommendation of the Sub-Committee of the Royal Society, one naval and two army medical officers were appointed to the Commission in 1906, to continue the investigation of the causation of Mediterranean Fever from the epidemiological side. Accordingly, the writers of this part of the Report arrived in Malta in April and worked there until October, a period which covers the season when the disease is most prevalent.

Epidemiological work on behalf of the Commission was begun by Dr. R. W. Johnstone, of the Local Government Board, in the fever season of 1904, and it was continued by Lieut.-Colonel A. M. Davies, R.A.M.C., in the following year. Dr. Johnstone's Report gives such topographical details as are of importance in an epidemiological enquiry, together with a general sanitary survey of the Maltese islands, and he deals comprehensively with the prevalence of Mediterranean Fever among the civil, naval, and military sections of the population. Lieut.-Colonel Davies devoted most of his time to a critical study of the disease as it manifested itself amongst the troops and the military families constituting the garrison in 1905, and he also furnished a detailed report on the sanitary condition of the various barracks in which the troops are housed and of the hospitals in which their sick are treated. The ground was, therefore, cleared to a large extent by the work of both of those observers, and this Report should be read in conjunction with theirs, as there would be no object in repeating information concerning which there is nothing new to record. Some overlapping will, however, be unavoidable, as, for example, in bringing tables or other matter up to date.

No limit was placed on the scope of the epidemiological work to be undertaken during the season of 1906, but we were aware that the Sub-Committee considered the following points as of special importance:—

1. The early and careful study of each case of Mediterranean Fever, and its surroundings.

2. The possibility of the conveyance of the disease to man by the use of goats' milk or its products.
3. Mosquitoes, flies, or other insects as possible carriers of the disease germs.
4. Facts bearing on the determination of the incubation period.

As our work proceeded, other points came to the front, *e.g.*, the question of place infection, the relation of simple continued and enteric fevers, the insidious nature of the onset of illness, etc. It early became evident that some attention to an analytical study of the statistical history of past years was essential, and that important information was to be obtained from comparison of the behaviour of the disease in other stations. Further, in our capacity of service medical officers, we were instructed to act in concert with the naval and military authorities regarding practical measures, such as the provision of isolation accommodation for military cases, and in recommending the application of any additional preventive measures in relation to both army and navy, or the modification of any of those already in use, which the course of investigation might suggest. In addition to the investigations relating to the services, steps were taken for keeping up the observations, commenced by Dr. Johnstone in 1904, as to the prevalence of the disease amongst the civil population.

This Report will, therefore, be divided into the following parts:—I, Naval; II, Military; III, Civil. Following Part III is a paper, contributed by Dr. A. Critien, of the Public Health Department, Malta, on goats' milk as a factor in the causation of Mediterranean Fever amongst the civil population. Finally, a general summary has been drawn up, in which are given the conclusions drawn from a critical examination of the naval, military, and civil observations.

Division I.—NAVAL.

By Staff-Surgeon F. H. A. Clayton, M.D., Royal Navy.

SYNOPSIS OF CONTENTS.

Section A.—Epidemiology of Mediterranean Fever in the Navy.

	PAGE
I. The connection of attacks of Mediterranean Fever with recent stay in the Royal Naval Hospital, Bighi	10
(a) Mediterranean Fever occurring in patients under treatment in hospital for other diseases	11
Short histories of cases almost certainly contracted in hospital	12
Cases with onset within eight days of discharge	17
List of patients who have actually developed Mediterranean Fever while in hospital for other diseases during 1905—6	18
List of patients who developed Mediterranean Fever within eight days of discharge after treatment for other disease	19
Patients who developed Mediterranean Fever at varying intervals after discharge from Bighi	19
Symptoms suggesting earlier infection	21
Comparison of the incidence of the disease in persons who have been resident as patients in hospital within the preceding three months with those in whom no history of any connection with hospital could be obtained	22
Description of Bighi Hospital	22
Distribution of Mediterranean Fever cases in Bighi Hospital and effect of propinquity on other patients	25
Relationship to the amount of susceptible and of infective material in hospital	26
Meteorological conditions	33
Relationship to type of disease for which the patient was originally under treatment	35
Direct evidence with regard to mosquitoes	35
Direct evidence with regard to milk infection	40
(b) Mediterranean Fever occurring among the sick berth staff	44
Proportion affected	44
Average duration of residence previous to contraction	45
Proportion in which various ratings are affected	45
Relationship of attacks to duties	45
Month of onset and proportion affected each year	52
Description of quarters	53
The outbreak among the staff in 1906	53
Relationship to previous attacks of illness	55
Facts elicited by study of individual cases in hospital staff	55
Milk history	56
Mosquitoes, contact, hand disinfection	56
(c) Mediterranean Fever occurring in the other residences and quarters	56
(d) Mediterranean Fever occurring in the hospital ship "Maine"	57
Accommodation and routine	57
Milk supply	58
Employment	58

PAGE

(*e*) Summary of the evidence obtained in connection with the contraction of Mediterranean Fever in the Royal Naval Hospital, Bighi ... 59
II. Analysis of cases showing no very definite connection with residence in Bighi ... 60
III. Occurrence of Mediterranean Fever among officers as compared with men ... 60
IV. The connection of outbreaks with docking ... 63
Description of docks and surroundings ... 63
Possible reservoirs of infection in the neighbourhood ... 63
Evidence of the presence of mosquitoes ... 64
Latrines ... 65
Possibilities of infection apart from convection by biting flies ... 65
Facts shown by the returns of docking referred to ... 65
Influence of previous hospital residence ... 66
V. The possibility of connection between attacks of Mediterranean Fever and sexual intercourse with infected persons ... 68
Facts elicited from the study of individual cases ... 70

SECTION B.—PREVENTIVE MEASURES INSTITUTED AGAINST MEDITERRANEAN FEVER IN THE NAVY.

I. Methods of prevention undertaken in 1906 ... 70
Protection from the attacks of mosquitoes ... 70
Disinfection of patients' effects ... 71
Control of milk supplies ... 71
Milk in the Fleet ... 72
Ice creams ... 73
II. Incidence of Mediterranean Fever since the foregoing measures were instituted ... 74
Incidence in the Fleet ... 74
Incidence among persons constantly resident in Malta ... 74
Incidence in Bighi Hospital ... 76
Conclusion ... 78

SECTION C.—PERSONAL INVESTIGATIONS.

I. The prevalence of Mediterranean Fever in separate ships during 1906
Battleships ... 78
Cruisers ... 86
Destroyers ... 90
II. Facts elicited by the study of individual cases ... 93
Time on station ... 93
Previous service on station ... 94
In dock or alongside dockyard ... 94
Cases occurring in the Service afloat ... 95
Exposure to infection ashore ... 100
Facts pointing to the contraction of the disease in Malta rather than elsewhere ... 102
Dockyard. Civilian, English ... 103
" " Maltese ... 106
III. A more complete history of the outbreak of Mediterranean fever on board the s.s. "Joshua Nicholson" ... 107
History of the goats ... 111

	PAGE
The incidence of Mediterranean Fever among those who partook of the milk	112
In the s.s. "Joshua Nicholson"	112
At Antwerp	112
In the s.s. "St. Andrew"	116
In America	116
Epidemiological observations	117
Duration of period between ingestion of goats' milk and the development of symptoms	120

The epidemiological work which has been undertaken this year may be divided into three sections: (A) Historical; (B) Preventive measures and the incidence of the disease since their institution; and (C) Personal investigations, including a study of the disease as it has occurred in separate ships, and of the facts elicited from enquiry into individual cases.

SECTION A.—EPIDEMIOLOGY OF MEDITERRANEAN FEVER IN THE NAVY.

In connection with the epidemiological section it was felt that where, as in sea-going ships, the environmental conditions were so perpetually varying, any attempt to study the history of the disease as it has occurred in separate ships would not repay the expenditure of time. Presence in or absence from Malta, the time of year, position in the harbour, and so on, are all factors that have to be reckoned with, and about which it is impossible to obtain accurate information.

Accordingly, attention has been concentrated upon the connection of Mediterranean Fever with conditions which are well known to influence causation or with considerable reason suspected to do so, and about which definite information can be obtained, and the study of the incidence of the disease in separate ships has been confined to the present year when the details of movements and of other conditions are available.

I.—THE CONNECTION OF ATTACKS OF MEDITERRANEAN FEVER WITH RECENT STAY IN THE ROYAL NAVAL HOSPITAL, BIGHI.

First and most important of the factors which are believed to have an influence in causation is:—

The connection of attacks of Mediterranean Fever with recent stay in the Royal Naval Hospital, Malta, either while suffering from other illness or as a member of the hospital staff.

This question has been investigated for the period from January, 1902, to the present year (1906), since this provides a quinquennial period, and one, moreover, in which the agglutination reaction and

the estimation of the dilution has been made use of as a routine method of diagnosis, the records being therefore correspondingly reliable.

(a) *As Patients under Treatment for other Diseases.*

The following table shows that every year a very considerable proportion of the naval cases, usually about one-third of those which come under treatment, have, at some time within the three months preceding onset, been in Bighi suffering from other illness.* It was, of course, necessary to investigate this previous hospital history for some definite period only, and three months has in consequence been taken as the limit, chiefly because it was found to include practically all the cases, as is shown in Table II.

Table I.—Showing the Proportion of Cases dealt with each Year which have been under Treatment in Bighi with other illness during the three months preceding onset.

Year.	Where under treatment.	Total cases dealt with, excluding relapses.	Proportion under treatment in preceding 3 months.
1902	In Bighi	293	83
	Elsewhere	—	—
1903	In Bighi	265	77
	Elsewhere	—	—
1904	In Bighi	259	95
	Elsewhere	—	—
1905	In Bighi	241	—
	Elsewhere	46	—
	Total	287	137
1906	In Bighi	120	—
	Elsewhere	55	—
	Total	175	79
	Grand total	1279	471

A few cases (21 in number) who were previously in hospital for illness which at the time was considered to be other than Mediterranean Fever, and was so classified, have been omitted from this table, either on account of the presence of a doubtful reaction during this first stay or because the subsequent history of the case has given reason

* The R. N. Hospital is situated at Bighi, and will be referred to throughout this paper under that name.

to doubt the accuracy of the original diagnosis. Moreover, in about a dozen of those included in Table I, the previous illness must be regarded as suspicious, although there was not sufficient evidence to justify amendment of the original diagnosis; but, with these exceptions, the patients may reasonably be looked upon as suffering from other illness. In deciding whether or not a previous illness was the first manifestation of Mediterranean Fever, one has to take into account the fact that it is not uncommon for the initial symptoms to reflect the previous medical history. Thus, in a case preceded by otorrhœa, the onset was signalised by a recurrence of the ear discharge; a second, with a history of head injury and resulting frequent headache, started with an epileptiform seizure; and records of more than one abscess or other surgical case have been met with where local recurrences accompanied the first signs of illness. After all, it is not extraordinary that a generalised infection should proceed along the line of least resistance.

The consistency with which so large a proportion of Mediterranean Fever cases present a similar history for a series of years disposes of the possibility of mere coincidence, but the following facts are also strongly suggestive that the majority of these cases were actually contracted in Bighi.

As is shown in Table II, a very considerable proportion may be regarded as almost certainly contracted there, and this, together with the enormous incidence among the sick berth staff constantly resident (*vide* p. 44), shows that the risk of infection is unusually great, and argues for a similar causation in the other cases.

A list, giving a short history of cases almost certainly contracted in hospital, follows. In this no patient has been included in whom there is not a history of at least 21 days' residence, with other illness before onset (the majority being far longer), or, among those who have been discharged, where the onset has occurred more than eight days after leaving. For 1905 and 1906 lists have kindly been provided by Staff-Surgeon Whiteside, but for previous years it has been necessary to consult the case sheets, and, owing to the longer limit of time, the number is smaller than that given by Dr. Johnstone in Part II of these Reports. If anything, therefore, it is probably under-estimated.

List of Cases almost certainly Contracted in Hospital.—1. W. P., Str.—Admitted to B 2 Ward on November 20, 1901, with venereal bubo, mass of protruding glands and slight temperature. Glands removed November 23 and temperature fell to normal and remained till February 20, 1903, 92 days after admission, when he had nausea, vomiting, and pyrexia for three days. Second rise of temperature, May 4, and on the 12th he reacted.

2. F. J., Str.—Admitted to E 1 Ward on January 29, 1902, with a broken down bubo. Operation February 26 and temperature normal till March 15, 46 days after admission, when he had temperature, anorexia, and pain in knee for three days.

Second operation April 13 followed by temperature and headache for 10 days. On May 31 fever returned and his serum reacted 1 in 40.

3. T. Q., Sigln.—Admitted to E 1 Ward on February 18, 1902, for hernia, for which operation was performed on 27th. He was well till April 13, 55 days after admission and when wound was healed. He then developed malaise and pyrexia and gave reaction 1 in 40 on April 17.

4. D. N., Lg. Seaman.—Admitted to E 2 Ward on February 25, 1902, with gonorrhœa. No developments till May 5, 70 days after admission, when he had headache and pyrexia and gave a positive reaction on May 13.

5. T. T., A.B.—Admitted to E 1 Ward on June 27, 1902, with simple fracture of both bones of leg. On July 19, coincident with an abscess of the leg and falling on incision of latter he developed fever and on August 4 this once more occurred. On August 24, 58 days after admission, he developed high temperature and headache, and on the 26th gave positive reaction.

6. R. H., Petty Officer.—Admitted on May 31, 1902, to E 1 Ward with a simple fracture of femur. Did well till August 27, 89 days after admission, when he had fever and headache for three days. Normal till October 23, when he had a recurrence of symptoms and reacted 1 in 50.

7. E. M., Petty Officer.—Admitted on July 29, 1902, to E 1 Ward with a compound fracture of lower third of femur, involving knee joint. By August 12 the wound was healed and he was up on crutches in September, but on October 11 he developed temperature and headache and reacted next day.

8. A. H., Yeoman of Signals.—Admitted to Zymotic Block on August 4, 1902, with a typical attack of enteric, giving negative reaction with *Micrococcus melitensis.* His temperature was normal by September 2, and so remained till October 15, 73 days after admission, when he had headache and persistent fever. Marked positive reaction on October 22.

9. P. H., Pte.—Admitted to E 1 Ward on August 27, 1902, with a lacerated wound of thumb. Three days' temperature and headache on September 23, 29 days after admission. Wound was healed by October 18 and on the 20th he had a return of symptoms and reacted 1 in 50 on the 22nd.

10. C. A., Signal boy.—Admitted on September 5, 1902, to E 1 Ward with a compound fracture of leg. On October 22, 47 days after admission, he developed fever, headache, etc.

11. G. W., G.M.A.—Under treatment in ship for months for eczema and was admitted on October 8, 1902, to E 1 Ward. On November 14, 36 days after admission, he developed headache and fever and reacted on December 22.

12. W. K., Cook's Mate.—Admitted on December 25, 1901, with multiple fracture of jaw. Wired on 30th. Had abscess at angle, with some fever on February 5. On April 10, 107 days after admission, he had malaise, headache and fever and reacted on April 15, 1 in 40.

13. W. S., Str.—Admitted to E 1 Ward on March 6, 1902, with hæmorrhoids, for which operation on March 11. On April 5, 30 days after admission, he complained of vertigo and temperature rose on 9th. Reaction on April 17.

14. H. T., Pte.—Admitted on June 30, 1902, to E 2 Ward with acute gonorrhœa. On July 26, 27 days after admission, had headache and fever and reacted on August 3.

15. E. M., Str.—Admitted on October 3, 1902, to E 2 Ward with gonorrhœa and epididymitis. On December 16, 75 days after admission, complained of abdominal pain and diarrhœa and had fever. He reacted on December 28.

16. H. B., Petty Officer.—Admitted on December 5, 1902, to E 1 Ward with multiple injury. On January 13, 1903, he developed headache and fever for a day or two, 39 days after admission, and on February 21 had a wave of fever with rigors, sweats, etc.

17. C. C., Pte.—Admitted on December 5, 1902, to E 1 Ward with a fracture of the leg. He did well till February 22, 1903, when he developed headache and fever, 79 days after admission, and reacted 1 in 50 on the 24th.

18. H. B., A.B.—Admitted on December 26, 1902, to E 1 Ward with fracture of jaw and other injuries. On May 21, 146 days after admission, he had rise of temperature and rheumatic pains and gave a positive reaction on the 27th.

19. A. R., Petty Officer.—Admitted to W 2 Ward on November 27, 1902, with sciatica. Disease had persisted for months without other symptoms and there was a strong rheumatic history. On December 28, 29 days after admission, he developed fever and headache and reacted on December 31.

20. E. Y., Pte.—Admitted on November 24, 1902, with tumour in iliac region and symptoms of appendicitis. Had one or two days' malaise and pyrexia on February 10, 78 days after admission, and on the 21st a second wave with enlarged spleen. Iliac region again tender.

21. S. L., Str.—Admitted to E 1 Ward on January 12, 1903, with simple fracture. About February 6 had pyrexia lasting five days, with painful swelling of jaw which was incised. Tonsils swollen. This was 25 days after admission, and 48 days later he had pyrexia and recurrence of swelling. Positive reaction five days after.

22. P. P., Maltese Shipwright.—Admitted to E 1 Ward on February 2, 1903, with a compound dislocation of the thumb. On March 9, 35 days after admission, had a rise of temperature, malaise, and vertigo. Reacted on March 14.

23. T. K., Str.—Admitted to W 2 Ward on March 28, 1903, with hæmaturia and dullness in left flank. Temperature normal. On April 28, 31 days after admission, developed fever and headache. Gave definite reaction on May 29.

24. I. J., Str.—Admitted to E 1 Ward on April 9, 1903, for hernia. After operation on May 7, 29 days later, the temperature never fell properly and on May 20 blood yielded a positive reaction.

25. H. L., Ord. Seaman.—Admitted to W 2 Ward on March 31, 1903, with pain over liver and jaundice. This had been preceded by inflammation of scrotum and liver enlargement followed. Temperature normal and steady improvement till April 21, 22 days after admission, when he developed temperature with pain in right flank and all over. Reacted on April 26.

26. W. S., Ord. Seaman.—Admitted to W 2 Ward, after several attacks of tonsilitis, for operation. Removed on April 13. On April 24, 24 days after admission, developed fever and headache. Reacted on May 11.

27. P. W., A.B.—Admitted to E 1 Ward on June 8, 1903, with ischio-rectal abscess. Steady improvement after operation, but on August 3 headache and diarrhœa began, and on August 10 his temperature rose and he reacted on the 16th. Onset 56 days after admission.

28. J. M., Str.—Admitted to E 2 Ward on July 18, 1903, with a suppurating patellar bursa. On August 11, 24 days after admission, there was slight pyrexia of nine days' duration with no symptoms. September 8, fever of a week's duration. September 21, the femoral glands, which had become enlarged on August 3, were opened up. This was at once followed by a rise of temperature and a positive reaction was obtained two days later.

29. W. F., Petty Officer.—Admitted to W 2 Ward on May 1, 1903, with well-marked signs of pleurisy and pericarditis. By June 3 was fairly well, but on this date, 34 days after admission, a slight rise of temperature occurred which persisted, and on June 23 he complained of pains all over. June 25 reacted 1 in 50.

30. E. A., Yeoman of Signals.—Admitted to C Ward on November 8, 1903, with hernia, for which operation performed. Healed by November 19, but on January 9, 1904, 67 days after admission, he had sudden rise of temperature and reacted next day 1 in 200.

31. J. F. C., G.M.A.—Admitted to E Ward on November 26, 1903, with otorrhœa, temperature normal. Quite well till February 10, 76 days after admission, when he developed headache and fever. Reacted on February 12, 1 in 50.

32. T. B., Ord. Seaman.—Admitted to E Ward on December 5, 1903, with discharge from ear. No temperature except 99°·2 on January 14, 1904, until January 31, 57 days after admission, when he had vomiting, headache and fever. Reacted next day 1 in 200.

33. E. S., Str.—Admitted to E 3 Ward on December 8, 1903, with enteric fever. Temperature fell about end of January, 1904, and he did well till February 24, 78 days after admission, when had rise of temperature. Reacted next day 1 in 50.

34. A. S., Ord. Seaman.—Admitted to E Ward on November 7, 1903, with ulcers of legs and enlarged glands. He was well till April 2, 146 days after admission, when he had rigors, fever and headache. Reacted next day 1 in 50.

35. A. L., Able Seaman.—Admitted to B Ward on December 15, 1903, for gonorrhœal rheumatism. Temperature rose about January 16, 1904, 32 days after admission, and a positive reaction was obtained the same day.

36. F. S., G.M.A.—Admitted to C Ward on December 16, 1903, with a contusion of thigh. Symptoms of fever first appeared on February 16, 1904, 62 days after admission, and a positive reaction was obtained the same day.

37. T. D., Able Seaman.—Admitted to B Ward on December 22, 1903, with gonorrhœa. No symptoms till January 14, 1904, 24 days after admission, when he developed fever, headache and shivering. This passed off rapidly, but recurred on February 10. Reaction present on January 14.

38. C. B., Stoker.—Admitted to C Ward on January 4, 1904, with a compound fracture of leg. Doing well till February 13, 40 days after admission, when there was a rise of temperature and headache for two days. This recurred on February 26 and reaction was present.

39. W. F., Able Seaman.—Admitted to E Ward for hæmorrhoids on January 19, 1904, which were removed on January 23. On February 13, 25 days after admission, there was a rise of temperature and headache, and the blood reacted in a dilution of 1 in 100.

40. J. N., Private.—Admitted on January 21, 1904, to C Ward for hernia, for which an operation was performed on January 27, the wound healing nicely. On February 27, 37 days after admission, there was a rise of temperature and headache, and the blood was found to react 1 in 10.

41. J. R., Private.—Admitted on January 25, 1904, to C Ward with a fracture of olecranon. On February 17, 24 days after admission, he developed headache and temperature, and gave a positive reaction next day.

42. C. S., Stoker.—Admitted to B Ward on April 7, 1904, with primary syphilis. Was all right until May 21, when he complained of headache and temperature rose. This was 44 days after admission, and three days later his blood gave a positive reaction.

43. E. J. S., Able Seaman.—Admitted on May 23, 1904, to W 1 Ward with well-marked attack of appendicitis and negative reaction. Was convalescent by June 24, but on July 6, 44 days after admission, he developed headache and showed a positive reaction.

44. M. H., Petty Officer.—Admitted on July 10, 1904, to A Ward with gonorrhœa. No symptoms till August 30, 51 days after admission, when he developed a temperature and headache. First reacted 1 in 300 on September 20.

45. B. M., Ordinary Seaman.—Admitted to E Ward on February 27, 1904, with rectal abscess. Operation on February 27, and temperature fell at once. Did well till April 19, 51 days after admission, when temperature suddenly rose, and a positive reaction was obtained next day.

46. D. M., Petty Officer.—Admitted on March 10, 1904, to Ward W 1 with definite signs of tubercle, T. B., in sputum. Was doing well and gaining weight, but about April 19, 40 days after admission, got rise of temperature and headache. Positive reaction on April 25.

47. T. D., Private.—Admitted on July 11, 1904, to Ward W 1 with well-marked symptoms and signs of pericarditis. This cleared up, but temperature began to rise about August 4, 24 days after admission, and from that time he had irregular pyrexia. First reacted on October 3.

48. B. B., Fitter.—Admitted on September 7, 1904, to A Ward with chancroid and bubo. On December 6, 90 days after admission, developed headache and high temperature. Reacted next day.

49. P. S., Able Seaman.—Had had a non-venereal bubo in his ship since June and was admitted with it to hospital on October 1 to D Ward. Glands extirpated on October 18, but no symptoms till November 23, 53 days after admission, when wound had healed. Then headache and rise of temperature and positive reaction.

50. A. H., Able Seaman.—Sick on board ship and in "Maine" since August 22 with a bubo and admitted to hospital on October 1 to D Ward. No symptoms till November 23, when pain in back, followed by headache and fever, 54 days after admission. Positive reaction two days later.

51. C. H., Stoker.—Admitted on October 1, 1904, to D Ward with disease of ear. No other symptoms till November 12, when headache and rise of temperature. Positive reaction four days later.

52. T. B., Stoker.—Admitted to W 4 Ward on October 1, 1904, with signs of phthisis, no temperature, but history of hæmoptysis. On November 17, 48 days after admission, developed chills, rise of temperature and so on, and gave a positive reaction on November 22.

53. J. McG., Stoker.—Admitted to A Ward on October 12, 1904, with gonorrhœa. On December 2, 51 days after admission, complained of headache and nausea, and had rise of temperature. Reacted on December 4.

54. C. R., Able Seaman.—Admitted to D Ward on October 28, 1904, with a simple fracture of leg. Began to feel ill about December 25, 57 days after admission, and first reacted on December 27.

55. B. I., Lg. Stoker.—Admitted to D Ward on December 4, 1903, with fracture of lower jaw. Wired on January 28, and on February 11 had swelling and tenderness at ankle and on next day fever and inflammation of pharynx and tonsil. Well by 18th, but had temperature again on February 21, and on April 2 had recurrence and gave positive reaction. First symptoms 70 days after admission.

56. J. McC., Private.—Admitted to B Ward on January 12, 1904, with syphilis primary. Doing well till February 6, when had headache and rise of temperature, 25 days after admission. Reacted five days later.

57. G. S., Stoker.—Admitted to E Ward on December 9, 1903, with an abscess of the chest wall. Improved greatly and was all right till January 24, 46 days after admission, when he developed sickness and fever. Reacted on February 11.

58. E. H., Able Seaman.—From October 17 to November 18, on board, sick with œdema of tonsils and was admitted on November 19, 1904, with well-marked diphtherial paralysis. Had one day's rise of temperature on November 21, but was then normal till December 24, 35 days after admission, when he developed fever and general pains and reacted on January 14.

59. T. R., Stoker.—Admitted to C Ward for hernia on October 11, 1904, and had operation on October 15. On December 3, 53 days after admission, developed high temperature and headache, and reacted on December 5.

60. W. W., Able Seaman.—Admitted to sick list on November 6 with bronchitis, and said he had night sweats, but no temperature at any time. Admitted to W 1

Ward on November 22, 1904, and had similar symptoms in hospital until January 21, when he developed headache, temperature and pains, 60 days after admission. Reacted on January 28.

Cases with Onset within Eight Days of Discharge.—1. R. G., Boy.—Was under treatment from February 28 to April 17, 1902, with abscess, and onset occurred five days after leaving.

2. A. M., Stoker.—Was under treatment in E 2 from April 10 to June 2, 1902, for scabies, and onset was seven days after leaving.

3. E. E., Chief Stoker.—Was under treatment for internal hæmorrhoids from June 11 to July 29, 1902, in E 1 Ward and symptoms probably began two days before leaving, but case is a little doubtful.

4. W. T., Chief Stoker.—Under treatment in E 1 Ward from May 20 to July 24, 1902, for hernia. Symptoms began at once on discharge.

5. W. B., Able Seaman.—Under treatment in W 1 Ward and afterwards Zymotic from August 1 to October 8, 1902, with enteric. Onset the day following discharge.

6. G. H. D., Able Seaman.—Under treatment in Zymotic Ward for enteric fever from August 1 to October 17, 1902. Onset the day after discharge.

7. A. F., Able Seaman.—Under treatment in E 1 Ward from October 10 to November 21, 1902, with fracture of jaw, and became ill at once on leaving hospital.

8. W. H. D., Stoker.—Under treatment in B Ward from May 10 to July 5, 1903, with syphilis primary, and symptoms began eight days later.

9. Mr. J. H., Lieutenant.—Under treatment in C Cabin from November 1 to November 25, 1903, with injury to knee, and symptoms began the day previous to discharge.

10. F. P., Ordinary Seaman.—Under treatment in A Ward from September 28 to December 16, 1903, with syphilis primary, and was never well after discharge.

11. F. C., Able Seaman.—Under treatment in D and C Wards from September 10 to October 31, 1904, with operation for hammer toe, and developed symptoms four days after discharge.

12. W. G., Stoker.—Under treatment in B Ward from October 1 to November 18, 1904, with syphilitic bubo, and developed symptoms four days later.

13. P. C., Stoker.—Under treatment in B Ward from October 12 to November 18, 1904, with chancroid, and developed symptoms eight days after discharge.

14. Mr. H. L. D., Commr.—In C Cabin from November 14 to November 28, 1904, with fissure of anus, and developed Mediterranean Fever seven days later.

List of Patients who have actually developed Mediterranean Fever while in Hospital for other Diseases during 1905–6, given by Staff-Surgeon Whiteside.

Name.	Rating.	Wards.	Disease on admission.	Date of admission.	Onset.	Interval in days.
W. B.	E. R. A.	F; D, Feb. 7	Disease of skin	Jan. 26	Mar. 10	43
J. H.	Ch. Str.	F; D, Feb. 7	„ bone	„ 26	Apr. 12	76
J. M.	Str.	A	Syphilis, prim.	Mar. 8	May 20	73
W. W.	S. Batt.	E 4	Enteric fever	„ 15	„ 4	50
H. M.	G. M. A.	B	Syphilis, prim.	„ 20	June 1	73
H.H.M.	Pte.	W 1; W 2, Apr. 26; W 1, May 15	Pneumonia	Apr. 15	„ 5	51
W. B.	G. M. A.	As above	„	„ 14	May 19	35
R. T. S.	Lg. Sn.	As above	Heart disease	„ 14	„ 28	44
R. B.	A. B.	D	Abscess	„ 17	June 9	53
C. P.	C. P. O.	C; D, Apr. 24	Fractured jaw	„ 17	May 31	44
T. Q.	Str.	C	Hernia	„ 20	June 9	51
A. C.	A. B.	W 2	Laryngitis	„ 29	„ 2	35
J. H.	Str.	D	Abscess	„ 29	„ 10	43
S. S.	A. B.	D	„	May 1	„ 9	39
J. L.	Str.	A	Sec. gonorrhœa	„ 4	„ 4	31
H. W.	C. crew	C	Fracture, Potts'	„ 21	July 5	45
E. B.	A. B.	Zymotic; E, Aug. 3; F, Aug. 7	Scarlet fever	June 7	Aug. 7	61
J. A.	Lg. Sn.	C	Varix	Aug. 29	Sept. 20	23
T. L.	Pte.	A; F, Nov. 6	Chancroid	Oct. 10	Nov. 29	50
T. B.	Pte.	A	„	Aug. 28	Oct. 9	42
A. J.	Pte.	A	„	„ 28	„ 11	44
W. T.	A. B.	B	Syphilis, sec.	Oct. 1	Nov. 14	44
W. K.	A. B.	F	Chancroids	Nov. 9	Jan. 7	59
P. S.	Str.	B 2	Disease of eye	Oc 1	„ 12	103
H. B.	Lg. Str.	E 2	Bronch. asthma	Jan. 27	Mar. 6	38
S. T. G.	Pte.	B; F, Jan. 30; A, Feb. 19	Bubo, venereal	„ 27	„ 14	46
A. R.	Str.	A; F, Feb. 9; A, Feb. 19	Syphilis, sec.	„ 30	„ 12	41
A. P.	Str.	A	Gonorrhœa	Dec. 12	Feb. 5	55
C. M.	Str.	B; F, Jan. 10; A, Feb. 19	Syphilis, prim.	„ 23	Mar. 6	45
G. C.	Signl.	A; B, Feb. 19	Gonorrhœa	„ 26	„ 18	77
H. J.	Str.	B; A, Mar. 23	„	„ 23	„ 24	91

List of Patients who developed Mediterranean Fever within Eight Days of Discharge after Treatment for other Disease during 1905–6.

Name.	Rating.	In hospital previously.	Wards.	Disease.	Date of onset.	Interval in days.
P. D.	O. S.	Feb. 16 to Apr. 17	C	Hernia	Apr. 25	8
W. L.	A. B.	Mar. 8 „ May 9	E 4	Enteric	May 11	2
G. R.	Str.	May 26 „ July 20	W 1, E, June 21	Colitis	July 24	4
J. McL.	A. B.	Aug. 26 „ Oct. 18	A	Chancroids	Oct. 21	3
A. M.	A. B.	Apr. 26 „ May 30	D	Fracture	June 3	4
J. M.	Fitter	Mar. 14 „ June 2	D	Wound	May 28	Nil
R. B.	B'ksmith	Oct. 4 „ Nov. 6	D	Hæmorrhoids	Nov. 9	3
H. F. C.	A. B.	Feb. 6 „ Apr. 26, 1906	B, A, Mar. 23	Syphilis, sec.	Apr. 19	3

Patients who developed Mediterranean Fever at varying Intervals after discharge from Bighi.—In addition to the number included in this list, the onset of the disease in very many more occurs within a few weeks of discharge, and the number proportionately diminishes in accordance with the period which has elapsed since leaving. This is well brought out in the following table, and also points strongly to some etiological influence connected with Bighi:—

Table II.—Showing the Numbers of Patients under Treatment for other Illness who developed Mediterranean Fever at varying intervals after discharge from Bighi.

Year of onset.........	1902.	1903.	1904.	1905.	1906.	Total.
Within a month—						
While resident	20	11	29	22	9	91
Within 8 days of discharge ...	7	2	5	7	1	22
From 8 days to a month	18	22	23	45	22	130
Between 1 and 2 months	22	25	30	45	30	152
„ 2 „ 3 „	16	17	8	18	17	76
„ 3 „ 5 „	5	6	1	4	4	20
Total	88	83	96	141	83	491–20

Two possible explanations of this heavy incidence among patients recently discharged from Bighi must here be discussed. It has been argued, in the first place, that the debility produced by the illness which occasioned their stay reduces the natural resistance so much that they become a ready prey to the disease on subsequent exposure to infection.

Many facts, however, militate strongly against this hypothesis. For one thing, men in naval hospitals are not discharged until they are fit for duty, and in many cases a considerable interval of apparently perfect health has intervened between discharge and the onset of symptoms. Not only is this the case, but Table VII (p. 36) shows quite distinctly that liability is as great after non-debilitating disease such as otorrhœa, simple tumour, and so on, as after many more exhausting ailments. Again, attacks of Mediterranean Fever are by no means confined to patients who remain on the station; they occur with as great frequency among those invalided, who only leave hospital to embark for passage to England. Included in Table I are 25 cases of this description during 1905–6, of which 11 had onset within a month of discharge, 12 within two months, and two within three months. Similarly, a few cases are included where, owing to the departure of the Fleet, patients have been sent to their ships while only convalescent, and have developed their symptoms without landing anywhere. These show similar intervals. Under both these heads there are, of course, chances of infection in the ship, but it may at least be said that the possibilities are greatly lessened by the exclusion of shore infection. The results of enquiry into the movements of patients between discharge from hospital and onset of illness, as detailed at p. 100, may be referred to as illustrating that the opportunities of exposure ashore are, in the majority of cases, quite limited.

A second attempted explanation for the special liability of hospital patients is that a latent infection is stirred into life by the debilitating influence of other illness. There are grounds for supposing that this does occur under certain circumstances, but in the present instance the evidence goes to prove that it is at least infrequent. The onset of disease would in that case correspond with the date of an injury or of an operation rather than occur long after the wound was healed. Besides, the proportion of officers (among whom the disease is far more common than among the men) who have been in hospital previously is, as will be seen later, a very small one. There seems no reason to suppose that debilitating circumstances should be more necessary to produce the disease in the seaman than in the officer.

It will be seen in Table XXIV (p. 74) that since April, 1906, coincident with the cessation of the occurrence of cases while resident in hospital, or within eight days of discharge, there has not only been a fall in numbers in the fleet generally, but no single case admitted has given a history of hospital residence within the preceding three months. This is a very striking and significant fact.

Nevertheless, to those who believe in an incubation period of rigidly definite duration, the acceptance of a relationship between residence in hospital and the occurrence of disease some six weeks to

three months later will be difficult. It must, however, be remembered that in experiments on animals the doses used have been large, and the occurrence of infection has been mapped out by continual and systematic examination for agglutination and not merely by the onset of symptoms which, indeed, need not necessarily occur. It is true that man is said to be more susceptible than animals, but there is nothing in these experiments to negative the possibility that he also can become infected without the occurrence of very definite symptoms. The subject is discussed at greater length elsewhere.

Symptoms Suggesting Earlier Infection.—With a view to the discovery of symptoms suggesting infection at an earlier stage in the history of these 471 cases, included in Table I, the hospital sheets of the majority of them were examined, with the result that about 47 were found to have exhibited symptoms at some time or another during their stay for which no very obvious explanation was forthcoming from their condition at the time. The following provide illustrative examples :—

W. T., Ch. Str.—Admitted for hernia May 20, 1902. Operation May 28. Healed by June 13 and allowed up. On July 8 had temperature and malaise lasting four days, with joint pains. Said he was never well after discharge on July 24, and August 23 was placed on sick list. Admitted October 9.

W. R., Str.—Admitted March 21, 1903, with gonorrhœa and perineal abscess. On incision of latter temperature fell to normal, but on April 7 temperature 101° and rigor. Wound healthy. Temperature persisted till 13th. Negative reaction. He was discharged on May 13, and on June 17 had first symptom of Mediterranean Fever.

H. B., Ordinary Seaman.—Admitted February 8, 1906, with venereal sore. Developed temperature, and headache March 16 and 17, but with negative reaction. Onset April 18 after discharge on March 27.

J. S., Str.—Admitted November 24, 1905, with chancroid and bubo. Developed a temperature and abdominal pain January 3, 1906, and headache, abdominal pain and temperature January 25. Discharged February 1, and onset of Mediterranean Fever on May 12.

It will be noted that in the list of cases contracted while still resident in hospital a very similar history is frequently given—a short preliminary canter in the shape of two or three days' temperature and malaise, followed in a few weeks by more definite symptoms and positive reaction.

It will be seen from this table that the difference is enormous, more particularly when it is taken into consideration that the Fleet number represents only the average, whereas the hospital number represents the actual total of individuals, and, moreover, that even this is over estimated, since several patients are admitted more than once during the year. One is, therefore, perfectly safe in asserting that, in the past, residence in Bighi for any other illness has enormously increased liability to the development of Mediterranean Fever within the next three months.

Table III.—Comparing the Incidence of Mediterranean Fever among previous Patients in Bighi and those in whom no History of Connection with that Establishment was to be obtained.

Year	1902.	1903.	1904.	1905.	1906.
Actual number of admissions to Bighi of patients suffering from illness other than Mediterranean Fever	1,284	1,158	1,346	1,480	261*
Actual number of these who subsequently, either during residence or within three months of discharge, are known to have developed Mediterranean Fever	96	85	86	170	28
Average number of men victualled in Mediterranean fleet yearly	18,470	18,410	19,590	14,360	—
Proportion of fever cases dealt with yearly, showing no previous hospital history	190	155	144	150	80

* First quarter only of 1906.

In addition, an examination of Tables IV and VII and Charts 1 to 5 shows quite conclusively that those cases, classed as almost certainly contracted in hospital, display a remarkable correspondence with those who merely developed it subsequently to discharge, both with regard to the time at which they were resident and presumably contracted the disease, the blocks in which they were treated, and the kind of illness from which they suffered.

To summarise:—

That large numbers of cases have year by year been contracted in Bighi is a well-authenticated fact.

A large proportion of cases admitted during each year give a history of recent residence there, and it is equally certain that liability to attack in the near future is very much greater among patients there than among the generality of their messmates.

In a great many the possibilities of exposure to infection between discharge and the onset of symptoms have been practically negligible. It is not therefore unreasonable to conclude that the majority of these persons have been infected while actually in hospital.

Description of Bighi Hospital.—In order to throw light on the method of infection in these cases, it is necessary to give a short description of the hospital and of some points with regard to the routine in force there. The grounds comprise an area of about 17 acres on a broad bluff of land some 50 feet above sea level, and projecting into Bighi

Bay on the southern side of Grand Harbour and between Rinella and Calcara Bays. Except, therefore, on the south-eastern side, it is entirely cut off from the adjoining land by broad strips of water, and is consequently separated from the thickly populated centres—the nearest, Vittoriosa, being at the least 260 yards distant. Ricasoli Fort to the north-east is 140 yards from the nearest point of the hospital, and Valletta is 700. The hospital proper, as opposed to the residential area, is on the north-west side, and is therefore furthest removed from the small village of Calcara, which adjoins the southern corner of the grounds, and is the only inhabited district that does so. The rest of the country adjoining is practically uninhabited, and herds of goats provide the only possible source of infection. It is obvious, therefore, that this is to be sought within the establishment itself.

The hospital proper originally consisted of two large one-storey blocks and of a central block. The former, which contains one large and two small wards on each side, separated by a broad central corridor, are known as the East and West Blocks respectively, and will be so referred to. They also contain cabins for officers at the corners and the basements are taken up for kitchens and other offices. Above these wards, under the eaves at each end, are two small rooms, now unused, but previously to October, 1902, the quarters of the Sick Berth staff. Just outside them and at the top of the stairway leading to them are large stone tanks, at present kept boarded up, but formerly open; these must have provided excellent breeding places for mosquitoes.

The wards have been modernised and are fitted with good sinks and latrines.

An infectious block was added on the western side in 1900, and a new general surgical block was first occupied in June, 1903. This latter block is three stories high, but, owing to the dip in the ground towards the Rinella side, where it is situated, its top storey is beneath the level of the old blocks.

Charts 1 to 4 also show that it is effectually screened from the west (the present Mediterranean Fever) block by the interposition of the east and central buildings. It consists for the most part of six large wards arranged in longitudinal series of twos. The ends and corners are filled in with small wards, the various offices, and cabins. Both this and the infectious block are built on modern lines and do not call for further remark in this direction.

On the southern or landward side of the grounds are the various quarters and residences, and the unoccupied areas are utilised as gardens or as asphalted catchment areas for the supply of the underground tanks. For this reason Bighi is singularly free from dust, and, owing to its encirclement by water, receives very little from without.

The arrangements for water supply constitute a noteworthy feature, as, owing to the insufficiency of the public supply or aqueduct for fire purposes, it is necessary to store water in a series of tanks.

Drinking water is supplied to all parts of the hospital from the aqueduct in iron pipes, the various taps being clearly labelled, "Fit for Drinking," but for the water for fire, lavatory, flushing, and garden purposes there are several distinct sources. First, there are 36 underground tanks, many entirely unused, and therefore containing water which is stagnant and full of vegetable matter. These are supplied by surface water, for which catchment areas are provided by the flat roofs of the hospital buildings and the asphalted surfaces of the grounds already referred to, while seven of them also have a supplementary supply from the aqueduct, the pipes being controlled by stop-cocks. No. 14 tank, situated close by the laundry, is used as a reservoir from which water is pumped by an engine near here into flushing tanks on the roofs of the various residences and of the Refractory, Zymotic, and Central Blocks, and also into the stone tanks already referred to as being under the roofs of the East and West Blocks. This water is used for lavatory and flushing purposes. In addition, there is a second pumping station on the Calcara side, below the Zymotic Block, which three times a week fills a third series of seven tanks, three each on the roof of the East and West Blocks and one on the Surgical, with sea water. This is used solely for the purpose of giving the drainage an additional flush, and is turned on once a day for five minutes, while at the same time those blocks and residences unprovided with the sea-water tanks are flushed by the fresh-water supply mentioned.

This brief description illustrates the fact that collections of more or less stagnant water are exceedingly numerous about the hospital grounds and buildings, and to these must be added a large number of garden surface tanks and tubs and the innumerable gullies connected with surface drainage. It also affords evidence that there is ample provision for flushing and that this essential procedure is thoroughly and regularly carried out.

Drainage.—The main drain is contained in a capacious tunnel which pierces the solid rock from the Rinella side to join the Government sewer at the southern corner of the grounds. The drainage from the Zymotic, East and West Buildings, join at their northern end and sweep round on the southern side of the Surgical Block to join the main drain at its northern end, so that the drainage from the Mediterranean Fever wards passes close to this building.

The drainage system is, however, every way up to date, is well supervised, and the arrangements for flushing are probably more satisfactory than almost any establishment in the island.

Sterilisation of Effects.—The clothing of Mediterranean as well as of infectious cases has for some time been sent to the disinfector on

admission, and where cases occur in the hospital, the regular procedure is that bedding and clothing are to be dealt with similarly.

Stringent regulations have been laid down with regard to disinfection of hands by the staff, after dealing with excreta of Mediterranean Fever cases.

The hospital may therefore be described as almost entirely isolated from the centres of population, unusually free from dust, built and administered on modern lines, and certainly in no way inferior in either respect to any hospital in the island, with a water supply above suspicion and a system of drainage which is found to work satisfactorily. There are, therefore, three main points which have a bearing on the question of the high incidence of Mediterranean Fever among residents there :—

First of all, in the close juxtaposition of sufferers from Mediterranean Fever with cases of other illness we have a large amount of susceptible material in the near neighbourhood of a possible source of infection.

Second. Mosquito breeding places are unusually numerous.

Third. The hospital has for years been supplied with goats' milk containing *Micrococcus melitensis*, and from the work of Staff-Surgeon Whiteside, referred to later, it is definitely known that this was, at least occasionally, drunk unsterilised.

The probable methods of infection resolve themselves, therefore, into direct or indirect contact, contamination of food-stuffs by various flies or their droppings, inoculation by biting flies, and ingestion of naturally infected milk.

Distribution of Mediterranean Fever Cases in Bighi Hospital, and Effect of Propinquity on other Patients.—With reference to the procedure adopted in isolating Mediterranean Fever, fortunately, during the period 1902 to 1906, different buildings have at various times been appropriated for the accommodation of these cases. A unique opportunity is thereby afforded for studying the influence of propinquity to the potential sources of infection in the production of the disease among other patients. It must be premised that before the introduction of an observation ward in June, 1905, the Mediterranean Fever block did not include absolutely all cases of the disease in hospital, as, in addition to undiagnosed cases under observation in the general medical wards, an occasional officer or man developing the disease elsewhere does not appear to have been transferred. For all practical purposes, however, the enormous bulk of infective material was to be found in these special wards, and it is justifiable to assume therefore that here, too, would be found the principal danger of contraction of the disease by contact or biting flies. Table IV, illustrated in the Charts 1 to 4, gives a history of the blocks, the approximate number of persons exposed to them, and the proportion who subsequently developed the

disease. It will be seen that the five years must be divided into four periods :—

(1) No isolation. Fever cases in general medical wards W 1 and W 2.

(2) Almost complete isolation. Fever cases in special ward W 1.

(3) Almost complete isolation. Fever cases in special wards E 1 and E 2.

(4) Complete isolation. Fever cases in special block (West), observation cases in special wards (W 3 and W 4) in this block.

In addition, therefore, to demonstrating the inefficiency of isolation by itself, which alone constitutes an argument against any form of contact infection, this table and the charts, pp. 27—32, show the following points :—

That equally during the first period when the cases were indiscriminately mingled with others, and during the second, when developed cases were kept together in one ward, the block which suffered most severely was the East, as far removed as possible from the source of infection, and containing surgical cases. This, which is noted alike with the almost certain and with the other cases, may be taken as suggesting the improbability of infection by contact or biting flies, and the possibility of a place infection (since on each occasion the same block was affected), or of something in connection with the surgical nature of the cases. That being so, it is interesting to note that the third chart puts an end to the idea of place infection, since with the removal of the surgical cases to the new block a similar condition of affairs is found there also. But since the Mediterranean cases were at the same time removed to the East Block, it might be argued that this offered some support to the theory of convection by biting insects, dust, or other contaminate infection.

The last chart, however, offers a decided argument against this conclusion, since with cases far more satisfactorily isolated at one end of the hospital, and with an observation ward provided, the incidence still continues to be highest in the Surgical Block, although removed as far as possible from the source of infection and screened from it by the intervening Central and General Medical (East) Blocks.

The conclusion that is forced upon one from a study of these charts is, that while cases are very generally distributed there is a special incidence upon surgical wards, and that residence in them is of greater importance in determining the development of the disease than propinquity to the Mediterranean Fever cases.

Relationship to the Amount of Susceptible and of Infective Material in Hospital.—Chart 5 gives these relations in graphic form. It will be seen that there is no definite connection between the number of persons resident each month who subsequently develop fever and the average number of reservoirs of infective material, in the shape of cases of the disease who were under treatment during that month. In

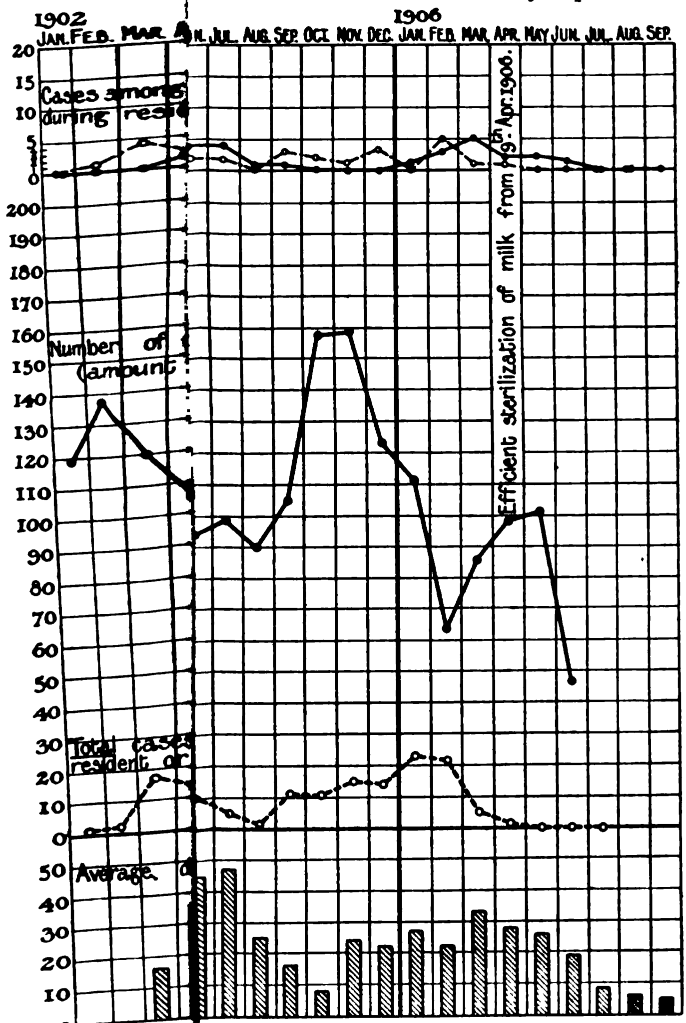

CHART 5.—S... ther than Mediterranean Fever), and of infective
mater..., from January, 1902, to September, 1906.
...isease was probably contracted.

Table IV (illustrated by Charts 1 to 4).—Giving, for each of the Four Periods dealt with, the approximate number exposed in each Block, the number known to have subsequently developed Mediterranean Fever, and the proportion (*in italics*) of those who almost certainly contracted the disease while in hospital.

Period.	Conditions.	West Block.			East Block.			Surgical Block.		
		Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.	Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.	Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.
January 1, 1902, to October, 1902	No isolation. West Block medical, East Block surgical	429 (medical)	13	*1*	611 (surgical and scabies)	52	*15*	Not open		
October, 1902, to end of June, 1903	Isolation begun. Mediterranean Fever cases in W 1 Ward. Observation cases in W 2	432 (medical)	26	*5*	497 (surgical and scabies)	41	*11*	Not open		
End of June, 1903, to June 22, 1905	Isolation. Mediterranean Fever cases in E 1 and E 2. Observation cases in W 1	1057 (medical)	64	*9*	24 (enteric, Jan., 1904)	10	*4**	1571	138	*45*
June 22, 1905, to end of first quarter, 1906	More complete isolation. West Block reserved for Mediterranean Fever	? (Mediterranean Fever Block)	5	—	421 (general medical from Aug. 21)	29	*1*	814 (medical cases in E and F from June 20 to Aug. 21)	74	*18*

* 3 enteric.

Table IV—*continued.*

Period.	Conditions.	Scabies Wards, Central Block.			Zymotic.			Refractory.		
		Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.	Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.	Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.
January 1, 1902, to October, 1902	No isolation. West Block medical, East Block surgical	—	—	—	57	5 (including enteric)	4	19	—	—
October, 1902, to end of June, 1903	Isolation begun. Mediterranean Fever cases in W 1 Ward. Observation cases in W 2	—	—	—	36	4	—	17	—	—
End of June, 1903, to June 22, 1905	Isolation. Mediterranean Fever cases in E 1 and E 2. Observation cases in W 1	93	2	—	32	3	1	24	1	—
June 22, 1905, to end of first quarter, 1906	More complete isolation. West Block reserved for Mediterranean Fever	57	—	—	3 ?	1	1	5	—	—

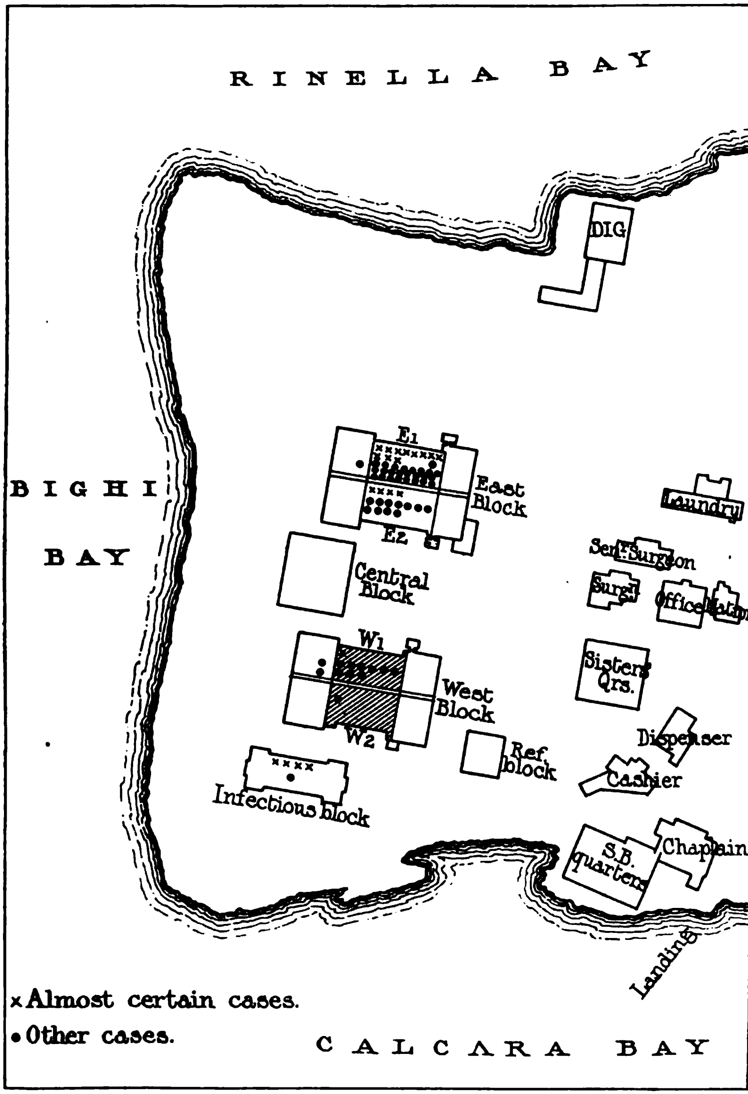

CHART 1.—*Period*—January to October, 1902. *Conditions*—No isolation. Mediterranean cases on W 1 and 2 with medical cases. Enterics frequently treated in Zymotic Block. W 1 and W 2, slightly shaded, show position of large majority of Mediterranean Fever cases.

	Cases.	Approximate number exposed.
In East Block	52	611
In West Block..................	13	429
In Infectious Block............	5	57

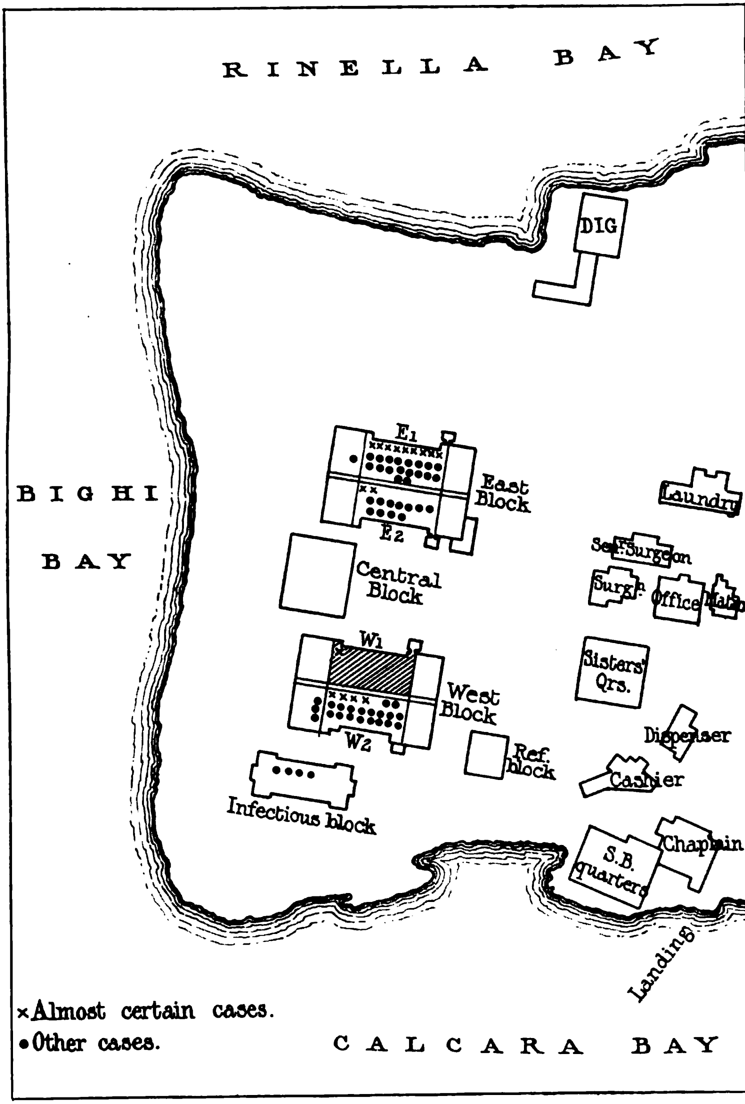

CHART 2.—*Period*—November, 1902, to June, 1903. *Conditions*—Fairly complete isolation. Mediterranean cases in W 1 ward. Observation cases with general medical cases in W 2 ward. Mediterranean ward shaded.

	Cases.	Approximate number exposed.
In East Block	41	497
In West Block...............	26	432
In Infectious Block.........	4	36

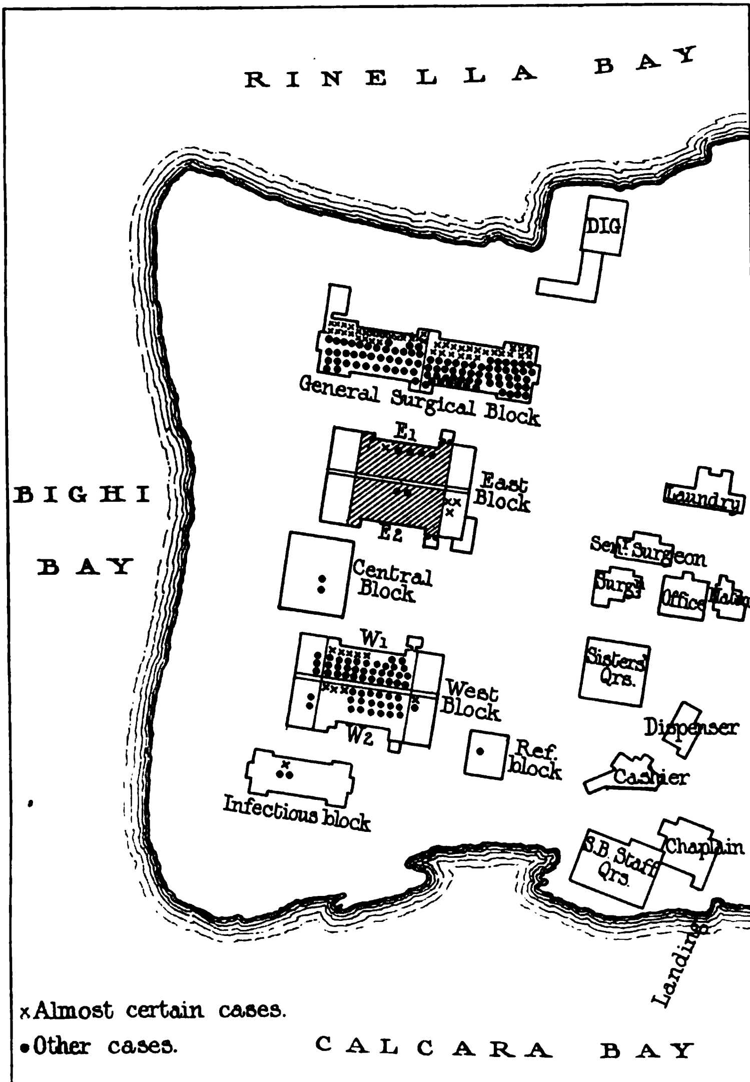

CHART 3.—*Period*—June, 1903, to June 22, 1905. *Conditions*—Fairly complete isolation. Mediterranean Fever cases in E 1 and E 2. Observation cases in medical wards W 1 and W 2. Surgical cases in Surgical Block. Mediterranean Fever wards shaded.

	Cases.	Approximate number exposed.		Cases.	Approximate number exposed.
In East Block.........	10	24*	In Infectious Block	3	32
In West Block	64	1057	In Central Block (scabies)	2	93
In Surgical Block ...	138	1571	In Refractory Block	1	24

* Entries since about January, 1904.

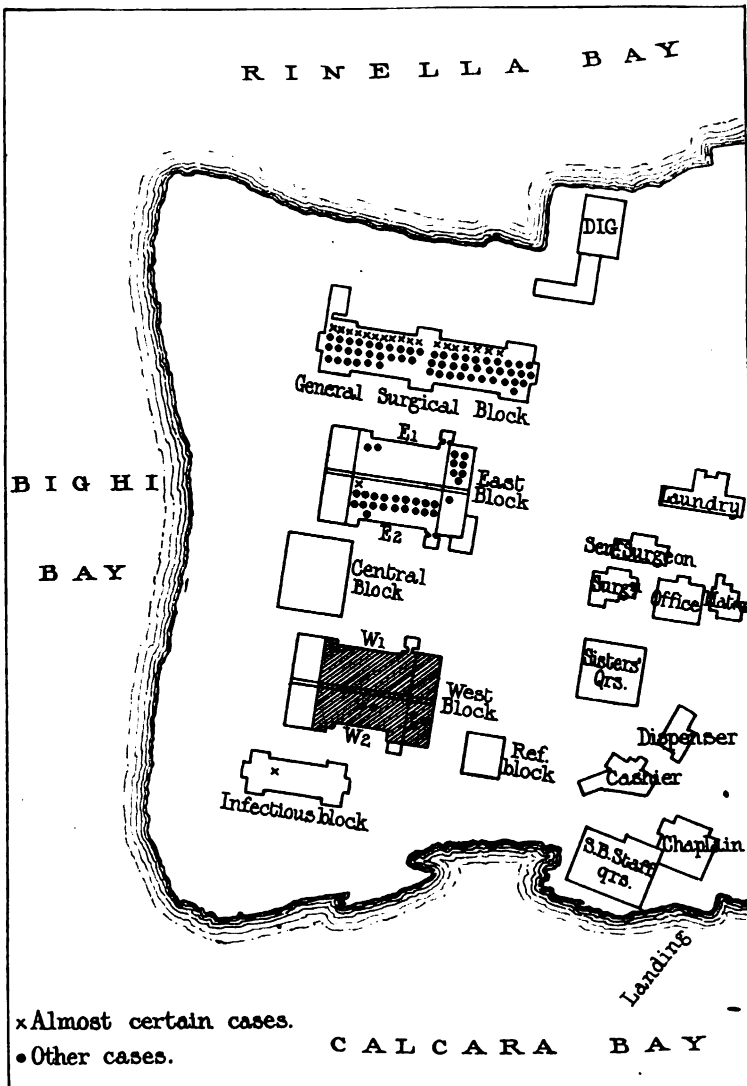

CHART 4.—*Period*—June 22, 1905, to April, 1906. *Conditions*—Complete isolation. Mediterranean Fever cases in W 1, W 2, and W 3. Observation cases in W 4. General medical cases in E 1 and E 2. Enteric cases in E 3. Mediterranean wards shaded.

	Cases.	Approximate number exposed.
In East Block	29	421
In West Block...............	5	?
In Surgical Block	74	814
In Infectious Block.........	1	3 ?

Naval Hospital ac harge

month

	Nov.	Dec.	Jan.	Jan.
	2	—	2	—
	6	—	3	—
	—	1	—	—
	—	1	3	—
	—	—	—	—
	—	—	—	—
	—	1		1
	—	—		—
	—	—	—	—
	1	—	6	—
	—	—	—	—
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			—	—
			—	3
	—	—	—	—
	—	—	—	—
	—	—	—	—
	—	—	—	—
	—	—	1	—
	—	—	1	—
			16	4

June 2

fact, in the majority of instances, an increase in the number contracted in hospital during any particular month appears to precede the months during which the largest average number of cases are under treatment, and probably is, to some extent, accountable for it.

As might have been expected, more cases appear to follow a high admission rate for diseases other than Mediterranean Fever, or, in other words, the amount of the latter disease contracted in hospital depends, to some extent, on the quantity of susceptible material exposed. The majority of cases are seen to occur in the winter when the hospital is most full, but there are occasional rises in the curve entirely independent of any recognisable factor.

Relation to Total Number of Cases of all Sorts under Treatment in Hospital and to Season.—Table VI, p. 34, compares the ratio of the number of Mediterranean Fever to other cases, and the ratio of the number of these latter subsequently developing fever to the total number exposed, and once more demonstrates an entire absence of any correspondence. Incidentally it shows that the rate is higher as a rule with a large total number of all cases under treatment, and lower when this is small, and that, therefore, the winter rate is usually higher than the summer, but that this rule is belied by occasional outbreaks which do not appear to depend upon season or the amount of infective material. Yet another argument against mosquito infection is therefore provided by Table VI.

Meteorological Conditions.—The daily temperature, rainfall, and direction and force of wind during 1905 and 1906 have been studied in relation to the occurrence of cases, but nothing can be discovered which appears to have any bearing on the exceptional prevalence at certain times, such as May, 1905, and January and February, 1906. At the former date the temperature was high and rising, and the weather very dry, at the latter the temperature was extremely low, and there was heavy rain. There was much wind at both seasons, but the force was perhaps greater in the two winter months. The wind which would most favour the convection of particles of dust or biting flies from the Mediterranean Wards to the Surgical Block would be any southerly wind in May, when the East was the Mediterranean Block, whereas in January and February, with the West as the Mediterranean Block as at present, a south-west wind is practically the only one which would produce much effect in this way, and the buildings are, in addition, screened from one another.

In May, north-west, south, and south-east were the prevalent winds, and the direction was southerly on 16 days.

In January, south-west, south-east, and east were the prevalent winds, and the direction was south-west on seven days.

In February the prevailing winds were north-east, south-west, west, and north-east, south-westerly on eight days.

Table VI.—Showing, for each quarter since January, 1902, the total number of cases of all sorts under treatment, the proportion of Mediterranean Fever cases and of cases of other illness, and comparing the ratio of Mediterranean Fever cases to those of other illness in residence during each quarter with the proportion of cases of other illness who are known to have subsequently developed Mediterranean Fever.

Year	1902.				1903.				1904.				1905.				1906.			
Quarter	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Total number of cases under treatment	563	605	431	486	498	518	383	611	603	526	443	532	605	605	452	584	476	368	—	—
Of which were Mediterranean Fever	65	129	71	81	93	119	97	101	112	95	53	82	73	130	87	54	75	75	—	—
Total cases other than Mediterranean Fever	498	476	360	405	405	399	286	510	491	431	390	450	532	475	365	530	401	293	—	—
Of which are known to have subsequently developed Mediterranean Fever	20	27	15	20	37	22	13	14	32	13	11	43	15	78	17	40	50	1*	—	—
Ratio of Mediterranean Fever cases to total under treatment	p. c. 11·5	p. c. 21·0	p. c. 16·4	p. c. 16·6	p. c. 18·6	p. c. 22·9	p. c. 25·3	p. c. 16·5	p. c. 18·5	p. c. 18·0	p. c. 11·9	p. c. 15·4	p. c. 12·0	p. c. 21·6	p. c. 19·2	p. c. 9·2	p. c. 15·7	p. c. 20·3	p. c. —	p. c. —
Ratio of cases of other illness who developed Mediterranean Fever subsequently	4·0	5·6	4·1	4·9	9·1	5·5	4·5	2·7	6·5	3·0	2·8	9·5	2·8	16·4	4·6	7·5	12·4	0·3	0	0

* This man was discharged on April 16 and became ill on April 19.

NOTE.—Cases subsequently developing Mediterranean Fever, and who are resident for more than one quarter, are entered for the quarter in which the disease was apparently contracted, or in which discharge from hospital occurred, where onset was subsequent to such discharge.

To that extent, therefore, the conditions may be said to have been favourable for dust or insect convection, but the subject is discussed elsewhere in more detail.

Relationship to Type of Disease for which the Patient was originally under Treatment.—Table VII gives the ratio of incidence in the various diseases for which the patients were under treatment. This once more brings out the fact that the distribution is very general, but that certain types suffer far more severely than others. Among those for which any large number were admitted it will be noticed that catarrh, simple continued fever, and influenza show a comparatively low ratio, whereas the opposite is the case with enteric fever, the initial stages of venereal disease, nervous and ear affections, pneumonia and pleurisy, practically all ailments affecting the digestive tract and the genito-urinary system, abscess, and injuries. There is a remarkable immunity in the case of tubercular disease, which may be due to the fact that such patients are invariably invalided and thus lost sight of, although an antagonism between the two is possible, especially in view of the results of experiments this year.

If, now, Table VIII, giving the proportion attacked in 1905 and 1906, according to duration of residence, is examined, it is first seen that a very large majority of attacks of Mediterranean Fever occur among patients who have been in hospital for prolonged periods, and, secondly, that diseases in which incidence is low are mainly those of short duration, while those in which incidence is high provide the greater part of the prolonged residence cases. In other words, prolonged residence would appear to explain the special liability of venereal and other surgical cases to attack, and, at least, may be said to be more important than any other condition yet discussed. This is the probable explanation of the special incidence in surgical wards. An interesting point in these two tables is the comparatively high incidence in sore throat and tonsillitis, which would provide a portal of entry for anything ingested in the mouth, as compared with other diseases of short duration. Indeed, there seems to be a specially heavy ratio among digestive diseases generally.

Direct Evidence with regard to Mosquitoes.—From the description of the water supply, the exceptional opportunities existing in Bighi for breeding of mosquitoes can be readily understood, and their prevalence is quite in accordance with anticipation. Surveys in and around the hospital were made on several occasions, and the following gives a brief summary of the result :—

The foreshore around Bighi itself is singularly free from larvæ-containing pools, and numerous examinations showed none. The same applies to the northern shore and head of Rinella Bay, and, owing to the fact that Calcara Bay has been so largely altered and made use of for wharves, landing-places, etc., very few can be found there either.

Table VII.—Showing Number of Cases admitted each year from January, 1902, to end of First Quarter of 1906, which were under Treatment in the Royal Naval Hospital, and the number of these which are known to have developed Mediterranean Fever later.

	1902.		1903.		1904.		1905.		First quarter, 1906.		Total.			Cases almost certainly contracted in hospital. Number who contracted Mediterranean Fever.
	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Percentage.	
Eruptive fevers, etc.	11	*1*	21	*2*	16	*2*	3	*2*	—	—	51	*7*	13·7	1
Other contagious general disease	1	—	13	—	8	—	4	*1*	—	—	26	*1*	3·8	1
Influenza	36	*1*	55	*6*	51	*2*	62	*1*	17	*1*	221	*11*	5·0	—
Fever, S. C.	23	—	22	*1*	47	*3*	28	*2*	1	—	121	*6*	5·0	—
Enteric	51	*7*	17	*1*	48	—	36	*9*	3	*1*	155	*18*	11·6	6
Septicæmia	2	—	—	—	—	—	—	—	—	—	2	—	—	—
Dysentery	7	*2*	4	*1*	2	—	2	—	—	—	15	*3*	20·0	—
Ague	2	—	1	—	10	—	1	—	1	—	15	—	—	—
Erysipelas	2	—	4	*1*	—	—	2	—	—	—	8	*1*	12·5	—
Tubercle	75	—	63	—	42	*2*	30	—	5	—	215	*2*	0·9	1
Chancroid	—	—	—	—	—	—	61	*9*	21	*6*	82	*15*	18·3	8
Syphilis, Pr.	65	*5*	99	*5*	72	*11*	57	*10*	1	*1*	294	*32*	10·8	10
„ Sec.	88	*2*	90	*2*	105	*5*	88	*7*	21	*2*	392	*18*	4·5	3
Gonorrhœa	57	*9*	76	*7*	99	*3*	100	*15*	14	*1*	346	*35*	10·1	9
Seg. Gon.	8	—	17	*1*	38	—	47	*6*	3	—	113	*7*	6·2	2
Scabies	40	*2*	15	*3*	42	*1*	63	—	14	—	174	*6*	3·4	1
Other parasitic disease	2	—	—	—	3	—	1	—	—	—	6	—	—	—

Plumbism and other poisons	1		1	—	3	—	10	4	1	—	16	4	25·0	—
Alcoholism	5	—	4	—	8	—	—	—	—	—	12	—	—	—
Rheumatism	55	*2*	32	*2*	44	*3*	32	*7*	7	*1*	170	*15*	8·8	—
New growth, non-malignant	6	*1*	16	*1*	20	*2*	25	*4*	—	—	67	*8*	12·0	—
„ malignant	—	—	1	—	4	—	3	—	—	—	8	—	—	—
Diabetes and other general disease	1	—	1	—	6	—	3	*1*	—	—	11	*1*	9·0	—
Disease of spinal cord	2	—	1	—	—	—	2	—	—	—	5	—	—	—
„ brain	2	—	2	—	3	—	4	—	—	—	11	—	—	—
Apoplexy	—	—	1	—	—	—	—	—	—	—	1	—	—	—
Paralysis	3	—	—	—	2	—	4	—	—	—	9	—	—	—
Epilepsy	11	—	8	—	6	*1*	6	*2*	2	—	33	*3*	9·0	—
Vertigo	—	—	—	—	1	—	2	—	2	*1*	5	*1*	20·0	—
Neuralgia	—	—	4	*1*	3	—	1	*1*	—	—	8	*2*	25·0	1
Other nervous disease	32	*3*	20	*2*	18	*1*	18	*3*	4	—	92	*9*	9·7	—
Insanity	17	—	14	—	12	*1*	—	—	2	—	45	*1*	2·2	—
Disease of eye	30	—	26	—	22	*1*	28	*1*	4	*1*	110	*3*	2·7	1
„ ears	23	—	14	*2*	16	*4*	23	*2*	3	*1*	79	*9*	11·4	3
„ nose	3	—	—	—	—	—	2	—	2	—	7	—	—	—
Heart disease, organic	31	—	8	*1*	12	—	14	*1*	2	—	67	*2*	3·0	1
„ functional	9	—	7	—	19	—	5	—	—	—	40	—	—	—
Aneurysm	2	—	—	—	—	—	2	—	2	—	6	—	—	—
Disease of veins	5	*1*	6	—	15	—	14	*1*	—	—	40	*2*	5·0	1
Other disease of circulatory system	—	—	1	—	2	*1*	—	—	—	—	3	*1*	33·3	1
Disease of larynx	1	—	2	—	1	—	1	*1*	—	—	5	*1*	20·0	1
Catarrh	61	*2*	42	*3*	30	—	90	*7*	9	*1*	233	*13*	5·6	—
Bronchitis	12	—	12	—	9	*1*	16	*2*	2	*1*	51	*4*	7·8	2
Hæmoptysis	1	—	3	—	4	—	—	—	—	—	8	—	—	—
Pneumonia	21	—	15	*1*	20	*1*	20	*5*	1	—	77	*7*	9·0	2
Phthisis	3	—	1	—	2	—	20	*1*	1	—	27	*1*	3·7	1
Pleurisy	11	*2*	22	*3*	21	—	15	*1*	3	—	72	*6*	8·3	1
Asthma	1	—	3	—	4	*1*	5	—	1	—	14	*1*	7·1	—
Other respiratory disease	2	—	—	—	—	—	—	—	—	—	2	—	—	—
Mouth, teeth, etc.	1	—	1	—	1	—	5	—	3	—	11	—	—	—
Sore throat, tonsillitis	35	—	34	*5*	40	*2*	59	*7*	12	*1*	180	*15*	8·3	1
Disease of stomach	5	—	17	—	18	*1*	10	—	—	—	50	*1*	2·0	—
„ intestines	30	*4*	29	*5*	31	*4*	40	*7*	1	—	131	*20*	15·2	3
Hernia	24	*4*	13	*2*	18	*2*	24	*7*	4	—	83	*15*	18·0	8
Hæmorrhoids	18	*5*	10	*1*	20	*3*	26	*5*	3	*2*	77	*16*	20·0	4
Fistula	4	—	7	*1*	2	—	2	*1*	1	—	16	*2*	12·5	—
Hepatitis	5	—	1	*1*	1	—	—	—	—	—	7	*1*	14·2	—
Other disease of liver	6	—	5	—	18	*3*	14	—	5	—	48	*3*	6·2	1

Table VII—*continued.*

	1902.		1903.		1904.		1905.		First quarter, 1906.		Total.			
	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Percentage.	Cases almost certainly contracted in hospital. Number who contracted Mediterranean Fever.
Disease of rectum	4	1	5	—	1	1	12	—	—	—	22	2	9·0	1
Bubo, non-venereal	14	2	10	—	3	3	15	2	7	—	49	7	14·2	2
Other lymphatic disease	9	1	4	—	2	—	9	4	1	—	25	5	20·0	—
Disease of kidneys	12	—	9	1	17	—	14	2	—	—	52	3	5·7	1
" bladder	5	—	3	1	1	—	2	1	—	—	11	2	18·1	—
Stricture	15	—	6	—	8	1	8	—	2	—	39	1	2·5	—
Varicocele	3	—	5	2	7	—	8	2	—	—	23	4	17·4	—
Orchitis	4	—	3	1	—	—	2	1	—	—	9	2	22·2	—
Other genito-urinary disease	9	—	13	—	16	3	22	2	3	1	63	6	9·5	—
Disease of bones	4	—	10	1	11	—	8	2	—	—	33	3	9·0	1
" joints	10	2	8	1	14	—	11	1	—	—	43	4	9·3	—
" spine	—	—	—	—	—	—	1	—	—	—	1	—	—	—
" bursæ	6	1	7	2	7	2	8	1	2	—	30	6	20·0	1
Other locomotory disease	—	—	1	—	—	—	—	—	—	—	1	—	—	—
Abscess	53	8	33	5	36	4	38	4	11	—	171	21	12·3	7
Ulcer	33	2	8	1	15	—	21	1	3	1	80	5	6·2	1
Boil and other skin disease	21	2	31	—	18	1	34	3	5	1	109	7	6·4	2
Injuries	133	24	119	9	155	10	135	11	48	4	590	58	9·8	23
Undetermined	—	—	2	—	—	—	2	—	1	—	4	—	—	—
Total	1284	96	1158	85	1345	86	1480	170	261	28	5528	465	8·4	113

1906 (third quarter).									
Under 10 days.		10 to 20 days.		20 to 30 days.		30 to 40 days.		Over 40 days.	
No. exposed.	Cases.	No. exposed.	Cases.	No. exposed.	Cases.	No. exposed.	Cases.	No. exposed.	Cases.
—	—	1	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—
5	—	2	—	1	—	—	—	—	—
—	—	—	—	1	—	1	—	4	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	1	—	—	—	—	—	1	—
—	—	—	—	1	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1	—	5	—
1	—	2	—	6	—	4	—	4	—
1	—	—	—	—	—	—	—	2	—
—	—	1	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	2	—	8	—	—			

The nearest point at which larvæ were found on the foreshore was on the northern side of the Breakwater and around the seaward face of Ricasoli, a point at least 500 yards from the nearest portion of the hospital grounds. They were found also in large numbers at the naval range at Ricasoli, and when bred out proved to be *Acartomyia Zammittii.*

The greater number of the underground tanks are situated in the residential area of the grounds, and here, also, the garden tanks, tubs, etc., are most numerous. Three of the underground tanks close to the Office Block were at one time or another found to be swarming with larvæ, which on being bred out proved to be either *Culex fatigans*, *pipiens*, or *spathipalpis.* In one or two more, one near the hospital proper, adult mosquitoes issued on opening, or cast larvæ cases were found, but larvæ were never numerous enough to be detected. The same three varieties of Culex were also bred out from some of the gullies and garden tanks, but none were ever found on any of the roof tanks.

The adult insects were also sent over for some months for identification. Of 156 examined, 75 proved to be *C. pipiens*, 56 *C. fatigans*, 22 *Stegomyia fasciata*, and 3 *Acartomyia*, the proportions thus corresponding very closely to those of Kennedy and Horrocks last year, and the small number of *Acartomyia* bearing out the observations made with regard to their breeding places. The first two were most prevalent in the early part of the year, Stegomyia in the latter part of August and September.

Since November 13, 1905, systematic oiling of all water traps and exposed tanks has been carried out in Bighi every Friday with, it is said, good results, although mosquitoes are still very numerous. In addition, all flushing tanks and exposed water tanks have been fitted with covers.

To exterminate them, however, in a place with such innumerable and inaccessible breeding places is a matter requiring a large staff in itself and constant supervision, and the hospital gardener and his assistants can hardly be expected to accomplish it.

Large square mosquito nets were fitted in the Mediterranean Fever wards at the end of June, 1905, and small ones in A and B Wards, and since October, 13, 1905, other wards have been gradually supplied.

Although these nets cannot be said to constitute a very efficient protection unless carefully looked after by the user, a very doubtful matter with the bluejacket, they must be regarded when fitted in the fever wards as not only protecting the patient to some extent from mosquito attack, but as preventing a certain proportion of infected mosquitoes, when full of blood and therefore sluggish, from escaping to be a possible danger to others. Accordingly one would expect some diminution as the result of their use, and the absence of such constitutes one more bit of evidence against this method of dissemination.

Direct Evidence with regard to Milk Infection. The Milk Supply at Bighi.—Goat's milk has always been the source of supply, and there has for a long time been a standing order that it should be boiled before issue to the patients, an order that was repeated in July, 1905. The goats were brought daily to the main gate of the hospital, being milked in summer just outside in a rather windy and dusty square, and in the winter inside a neighbouring dairy shed. The milk was collected in 10- and 24-pint cans, the former, according to the goatherd, holding on the average the milk of four animals and the latter of eight to ten. In these it was conveyed three times daily, at 5.30 and 9.15 a.m., and 1 p.m., to the hospital kitchen for the patients and to the various quarters for the staff, sterilisation being presumably effected in each separate place.

In the kitchen the apparatus in use consisted of three copper pans, in which the milk was heated until about 98° C., this taking about 50 minutes on each occasion, and necessitating continued stirring.

To facilitate rapid heating, instead of emptying a can bodily into one copper pan, a little was added to each of the three. It was subsequently conveyed to the wards in other special receptacles.

This method was so obviously imperfect that an Aymard steriliser had some time ago been applied for and approved, but up to the end of March it had not been fitted.

From the above facts it is evident that the milk must have undergone considerable dilution before issue. It is evident, too, that with Maltese cooks, possessed of profound faith in the virtues of goats' milk, we cannot feel certain that effective sterilisation had been carried out when the total number of cases in hospital was great and the work of boiling correspondingly heavy.

Evidence that the Milk was Infective.—Shaw first examined the goats supplying the hospital in July, 1905, and found that out of 91 goats 30 presented an agglutination reaction, and the milk of 9 yielded the *Micrococcus melitensis.* The organism was proved to be infective for monkeys. In March, 1906, the goats were again examined by Whiteside, and, out of 78, an agglutination reaction was presented by 21, and 5 of these presented Micrococcus. On July 3, 1906, the herd was once more examined by Zammit, and, out of 46, 7 were found to react. For reasons given subsequently, the examination was not persisted in.

Evidence of Ineffective Sterilisation.—As will be seen on p. 71, Whiteside has established, beyond the possibility of doubt, that occasionally, at least previously to April 8, 1906, sterilisation was not properly carried out in the kitchen. It follows that milk cannot be eliminated as a possible vehicle of infection in any case before that date.

The ingestion by a patient in any particular part of the hospital of a dose of infective milk would, to a large extent, therefore depend

upon a combination of factors. The presence of goats in the herd who were excreting *Micrococcus melitensis* may be assumed, from the examinations, to be practically constant.

From the method of collection it is evident that, as a rule, the milk must have been greatly diluted, but that at any time chance may have decreed that one can or one sterilising pan should have contained the milk of a large proportion of infected goats, and thus produced a much more highly infective dose than usual.

A third factor would be the varying efficiency of sterilisation.

In addition to these we have to consider the individual susceptibility of the persons drinking it. Whatever may be the reason, whether it depends on the presence of mouth lesions or not, there can be no question that individual susceptibility to this method of infection, if accepted as a method, must vary, since at the time of Whiteside's observation numerous men, who have not since suffered, drank the milk which was proved to have been infective.

Duration of residence, therefore, by favouring the combination of these factors, and the presence of a large number of patients in hospital, by increasing the chances of ineffective sterilisation, may be regarded as circumstances which would favour the possibility of milk infection.

Evidence of Milk Drinking.—Of the 471 cases under consideration no notes are available in the case of 14, but in at least eight of these the disease from which they were suffering afforded a practical guarantee that they would be on milk diet, and in the rest it is probable. Of the remaining 457 no milk is noted on the case sheets of six, while the remainder all had it in varying quantities. One of these six cases was almost certainly contracted in hospital and developed the disease while resident there. One, however (the only patient among the 471 resident for so short a time), was only in hospital three days, and the chances are against his having contracted it there. The disease from which they suffered was: Syphilis primary in three cases, gonorrhœa in one, fracture in one, and new growth in one :—

Table IX.—Showing the Total Amount of Milk Ingested.

Amount in pints	Under 5.	6 to 10.	11 to 20.	21 to 30.	41 to 60.	Over 60.
No. of patients	20	19	50	106	81	175

The vast majority are seen to have had a considerable amount, and there is almost a progressive rise in the numbers to the larger

quantities. This is brought out distinctly in the next table giving the number of days on milk, an even more important point to investigate, taking into consideration the probable intermittency both of sterilisation and the supply of infected milk:—

Table X.—Showing the Number of Days on Milk.

Days ...	1.	2 to 5.	6 to 10.	11 to 20.	21 to 30.	Over 30.
No. of patients	19	31	56	88	81	177

Table XI.—Giving the Interval between the last Issue of Milk and the Onset of Symptoms of Mediterranean Fever.

Interval in weeks	None.	Under 1.	Under 2.	Under 3.	Under 4.	Under 5.	Under 6.	Under 7.	Under 8.	Over 8.
No. of patients	74	16	25	20	42	46	33	46	26	123

Naturally the cases which had been discharged for some time provide the majority of long intervals, and, equally naturally, those contracted while resident give practically all instances of no interval.

It is interesting, therefore, to give the intervals exceeding three weeks in those with onset while resident, within eight days of discharge, and from nine days to a month of discharge respectively:—

Table XII.—Showing the Intervals exceeding Three Weeks in Cases giving the greatest Probability of Infection in Hospital.

Interval in weeks......	Under 4.	Under 5.	Under 6.	Under 7.	Under 8.	Over 8.
While resident	4	3	2	—	1	1
Within 8 days	—	2	2	1	—	1
From 9 days to 1 month	39	22	7	9	4	7

This shows clearly that if milk is to be accepted as the vehicle of infection in these cases—and it is difficult to avoid this conclusion when the results of effective sterilisation, as detailed on p. 74, are taken into consideration—the prevailing ideas with regard to the duration of the incubation period, considered as the interval between ingestion of

the infective milk and the onset of definite symptoms, will have to be considerably modified.

There would be nothing in the experimental work yet done to negative this view, as the interval is consistently shown to be lengthened in this mode of infection as compared with inoculation.

An interesting point is brought out in this investigation with regard to patients suffering from Scabies, who are not usually given milk. The circumstances were examined into in eight of these, although only six were included in Table I, as one was only 17 days in hospital before developing symptoms and another had been discharged for more than three months. All, however, without exception, had had milk, four only for a short time, but the remainder for a considerable time. It would, therefore, appear that the Scabies cases which eventually develop Mediterranean Fever are picked out from the very small proportion who are given milk.

Control.—Staff-Surgeon Richards kindly provided a list of the patients in his wards in the early part of 1906, with the particulars shown in Table XIII:—

Table XIII.—Giving the Milk History of a Series of Cases in the Venereal Wards.

	No milk.	Very little milk.	Fair amount.	Large amount.
Cases not developing Mediterranean Fever	20	23	50	34
Cases developing Mediterranean Fever......	1*	1	16	14

* This man, a S.B. attendant in hospital, admitted having drunk half a pint of unsterilised milk in his own quarters daily.

Although this evidence is on the whole in favour of milk, it shows once more that the individual must be taken into account, as some men from the dates given must have been taking the same milk and for as long a time as those who developed the disease. This, however, is in accordance with experimental evidence.

In the next table is shown for each ward during the year 1905 taken as a whole :—

(1) The total amount of milk consumed.

(2) The average consumption per head.

(3) The ratio of patients in the different blocks who subsequently developed fever to the total number of diets issued. By working out this ratio the duration of residence which has been shown to be of such importance is eliminated as a factor, inasmuch as the cases are regarded collectively rather than individually.

Table XIV.

Ward.	Description of use.	Days in use.	Total milk in pints.	Average per head, daily.	Total number of diets issued.	Cases of Mediterranean Fever.	Ratio of cases to daily victuallings.
							per cent
W 1	General medical to June	144	7708	2·0	3741	14	0·61
W 2		120	3180	2·1	1468	18	
E 1	General medical after August	49	783	1·8	417	3	0·44
E 2		132	6674	2·4	2800	12	
E 4	Enteric	335	5017	2·9	1732	7	
A	Venereal	295	5733	1·0	5302	14	0·30
B	,, ...	347	8597	1·1	7406	16	
C	Operation	365	6520	1·4	4632	13	
D	Septic cases	354	7791	1·5	5204	22	
E	General medical, June 20—Aug. 21	170	3103	1·6	1913	9	
F		237	5022	1·4	3424	12	
	Zymotic	261	715	2·1	261	2	0·76
	Officers, surgical ...	258	1758	2·4	729	4	0·54

Quite a decided correspondence is here shown between this ratio and the average consumption per head, and the fact that the ratio in the medical wards, when taken in this way, is higher than that in the surgical constitutes a further bit of evidence in favour of the view that it is duration of residence which is the chief factor in production of the high incidence in the latter.

(b) *Mediterranean Fever occurring among the Sick Berth Staff.*

The heavy incidence among hospital attendants in Malta has long been a matter of common observation, and no investigation of the prevalence of the disease in hospital would be complete without taking into account this particular section of men. As great a number of cases as possible have been enquired into, but only since 1901, as in previous years the agglutination reaction was not established as a routine method of diagnosis.

*Proportion Affected.**—From January 1, 1902, to June 16, 1906, including 20 men who were already serving on the former date, 171 separate individuals have been borne on the staff at Bighi, and of those 80 are known to have contracted the disease, while three more of the 20 already serving had had it in previous years. About 47·6 per cent. therefore have at some period or other during their residence fallen victims to it.

* About half a dozen men who were under two months on the staff and were not attacked have not been included.

Average Duration of Residence Previous to Contraction.—The shortest period recorded is one of 25 days, and in this case the patient had contracted gonorrhœa in Malta, and was under treatment for that affection when his symptoms appeared. See p. 69, Case 5.

In five the onset was under two months, and in seven under three, a total of 13 within that time; 17 occurred between the third and sixth month, and two between six months and a year; 22 more contracted it during their second year, and six during their third.

Taking into consideration the manner in which new arrivals are victimised by mosquitoes, this comparatively lengthy period is not altogether compatible with the theory of dissemination by biting flies, and it has been thought worth while to see if the men joining in the hot weather are attacked earlier than those joining in the winter. Of 38 attacked, therefore, who arrived between April and September, the duration of residence in seven was under three months, and in eight between three and six, while of 41 joining during the winter period the figures were seven and nine respectively. The case with only 25 days joined in Msrch.

Table XV.—Showing the Proportion in which various Ratings are affected.

Rating	Ch. S.B. stds.	S.B. stds.	2nd S.B. stds.	S.B. attendants.
Total exposed	7	12	24	127
Contracted fever	4	5	8	61
Percentage	57	42	33	48

Three of the attendants are known to have been protected by previous attack.

These figures show quite as great a liability among those not in actual attendance on the sick as among the nursing section.

Relationship of Attacks to Duties.—Table XVI shows the duty upon which the patient was engaged immediately or closely preceding the onset of the attack in the cases occurring during each of the four periods into which the time under consideration has previously been divided. See p. 46.

Table XVI.—Giving the immediate Duty engaged upon, as compared with the Average Number employed, among the 80 S.B. Staff who suffered from Mediterranean Fever since January, 1901. One ambulatory case omitted.

Period I.—No isolation. January, 1901—October, 1902.

Ward or duty employed in or upon.	Employment of ward.	Cases among staff.	Average number employed.	Remarks.
Officers	Medical and surgical cases	4	7	
East I and II ... East III and IV	Surgical cases	3	5·4	
West I	Medical, including Mediterranean Fever cases	5	4·3	Of these—1 was only employed 14 days and 1 was only employed 9 days. In East Block previously. 1 was only employed 9 dys. and in zymotic previously; 1 was only employed 7 dys. and previously with officers; 2 others were on night duty
West II		2		
West IV		—		
Surgical Block ...	Not opened yet			
Zymotic Block ...	—	1	—	Night watch for 19 days. W 2 for 7 days previously
Night patrol	—	1	—	This was succeeded by rheumatism for a month. Then worked in officers' cabins for a month and was sick June 5, 1902, with neuritis, both sciatics
Mess kitchen......	—	1		
Ch. S.B. stewards	—	3		
Total	—	20		

Table XVI—*continued.*

Period II.—Almost complete isolation. October, 1902—June, 1903.

Ward or duty employed in or upon.	Employment of wards.	Cases among staff.	Average number employed.	Remarks.
Officers	Medical and surgical cases	2	6·5	
East I and II ... East III and IV	Surgical cases	3	7	
West I	Mediterranean Fever	1	4	
West II......... West IV	General medical and observation Tubercle	—	3·6	
Surgical Block ...	Not opened yet			
Zymotic Block ...	—	1	—	G. D. for 5 days immediately preceding sick list. Night duty in zymotic
Mess kitchen......	—	1		
General duties ...	—	1	—	For 11 days. Night watch in E 1 previously
Total	—	9		

Table XVI—*continued.*

Period III.—Almost complete isolation. June, 1903—June 22, 1905.

Ward or duty employed in or upon.	Employment of wards.	Cases among staff.	Average number employed.	Remarks.
Officers	Medical and surgical cases	6	6	1 of these for 9 days only. General duty previously. 1 on sick list just previously
East I and II ...	Mediterranean Fever wards	4	7·3	
East III and IV	Enteric ward	2		
West I	General medical and observation wards	1	6	Zymotic subsequently for for 21 days preceding relapse
West II.........		1		
Surgical Block ...	Surgical. Opened June 15, 1903	7	12·5	
Zymotic Block ...	—	1	—	Zymotic for 20 days. Previously on list with dyspepsia
Laboratory	—	2		
Night patrol......	—	2	—	1 had just been sick with epididymitis
Mess kitchen......	—	1	—	For 11 days only. The surgical side previously
General duties ...	—	2	—	1 for 9 days. Night watch west wing previously
Ch. S.B. stewards	—	1		
Refractory Block	—	1	—	For 12 day only. In zymotic previously
Total	—	31		

Table XVI—*continued.*

Period IV.—Complete isolation.

Ward or duty employed in or upon.	Employment of wards.	Cases among staff.	Average number employed.	Remarks.
Officers	Medical and surgical cases	3	4	1 surgical side, 2 medical side
East I and II ...	General medical wards	2	6·4	1 night duty
East III and IV	Enteric ward	—		
West I	Mediterranean Fever wards	2	6	1 night duty E wing for 3 nights just before sick
West II.........		1		1 probably a relapse case
West IV	Observation ward			
Surgical block ...	Surgical	10	11	1 night duty E wing for 6 nights, 1 mess kitchen for 4 days, 1 for 18 days W1, before which medical
Mess kitchen......	—	1		
General duties ...	—	—	—	1 case employed in various wards, but exclusively in Surgical Block, and is there included
Total	—	19		

It is seen that of the total number (79),* 15 had been working in the Mediterranean Fever wards just before going sick, but that one of these was almost certainly a relapse, and four others were employed here for so short a time that there is considerable reason for doubting any connection.

One notable feature is the large proportion attacked while in attendance on officers, not necessarily Mediterranean Fever cases, and it is curious also that of those who were attacked while on duty in the Mediterranean Fever wards so large a proportion should have occurred before isolation was adopted.

A record of night duty is to be found in 13 out of the 79, and in three of these a period of general duty, lasting five, nine, and 11 days respectively, intervened between the spell of night duty and their going on the sick list. Only in three cases was the duty in the Mediterranean ward, and two of these occurred during the period before isolation. The third, E. B., was on duty in the East wing from

* One ambulatory case omitted.

April 26 to May 1, 1905, and was placed on the list on May 14. He had previously been for months on day duty in these wards.

Of the rest, three were on night patrol, two on night duty in the Zymotic Block, one in E 1 when it was a surgical ward, one in the General Medical Block in 1904, and three closely following one another on duty in the East Block in 1906. In two of these latter, however, the period of duty there was only three and six days respectively, so that the chances of infection being then contracted are distinctly dubious.

Practically half the 13 and all the most suggestive cases occurred before isolation was adopted, and the evidence derived from this analysis of the employment at the time of onset cannot be said to favour the idea of infection by direct contact, as the result of attendance on Mediterranean Fever cases, or inoculation by biting flies. Once again, the chief characteristic is the very general distribution.

The consideration of the immediate duty upon which the patient was engaged to some extent loses its value as evidence from the fact that it is so difficult in this disease to determine the date of the first manifestations, more particularly when dealing with persons constantly exposed to the danger of infection. In the following paragraphs, therefore, the presence or absence of infection in those who did or did not work in the Mediterranean Fever wards is dealt with without discussing the question of dates:—

Before isolation was started in October, 1902, there had been from January 1, 1901, 31 persons working in the wards in which Mediterranean Fever was treated, of whom 13 developed fever during this period, and seven long afterwards. During the same time, of 16 who had not been on duty there seven developed the disease and three more subsequently.

After the commencement of isolation in October, 1902, down to June, 1906, of those members of the staff who have joined after July, 1902, 73 at one time or another have served in the special Mediterranean Fever wards either by day or night, or both, and of these 33 have subsequently fallen victims, but in one the case was an ambulatory one, and the man never went sick. Two, however, were made more or less immune by a previous attack in 1900. During the same time, of 59 men who have never worked in these wards 25 have developed fever. This latter section naturally includes also a larger ratio of recent arrivals, and therefore persons who have been less exposed to risk of infection.

Examining into the question of night duty in the same way, it is found that of 17 persons on night duty in the block in which these patients were treated before isolation was started, five were attacked during the period and six long after, while of 46 on duty in the

special fever wards after October, 1902, 15 subsequently suffered from fever.

Those on duty in summer would naturally be more exposed to the chance of infection by mosquitoes, yet if we divide the year into two periods we find the number attacked to be practically equal in both. As many men, however, have been on duty both in winter and summer, no accurate table can be constructed.

Since the introduction of mosquito nets in the fever wards in 1905 there have been only two cases out of 12 men exposed on night duty, which would appear to offer support to the theory of mosquito convection, but a large proportion of these men are recent arrivals, and since March, 1906, other factors have to be considered, so that a comparison is not exact. A similar objection applies to the day duty figures, which give 30 cases among 52 persons on duty before June, 1905, and only 10 cases out of 39 persons (including several of the preceding 52) for the subsequent 12 months.

Table XVII.—Showing Duration of Duty in Mediterranean Wards by Day and Night from October, 1902, to end of May, 1906, and the Proportion Attacked.

Time in days.	Number exposed.	Number attacked subsequently.	Remarks.
Under 20	7	4	
Between 20 and 40	16	8	
„ 40 „ 80	16	6	
„ 80 „ 120	11	5	1 other in 1900
„ 120 „ 200	13	7	1 „ 1900
„ 200 „ 300	7	2	
Over 300	2	1	An ambulatory case
Total	72	33	

Table XVIII.—Showing Duration of Night Duty alone.

Time.	Number exposed.	Number attacked subsequently.
Under a fortnight	10	3
Between 2 and 3 weeks	7	3
„ 3 „ 4 „	4	2
„ 4 „ 5 „	17	4
„ 5 „ 6 „	4	2
„ 6 weeks and 2 months	3	1
Over 2 months	1	—
Total	46	15

Taking as a whole the evidence with regard to the nature of the duty upon which the Sick Berth Staff have been engaged, it must be held that very little connection can be discovered with work amongst the fever patients, either by day or night, winter or summer, and that, just as with the hospital patients suffering from other illness, propinquity to these cases seems to exercise little influence in determining an attack.

Table XIX.—Month of Onset and Proportion affected each Year.

Month of onset.	1901.	1902.	1903.	1904.	1905.	1906.	Total.
January	—	—	1	1	—	1	3
February	—	—	—	3	—	3	6
March	2	—	1	2	1	5	11
April	1	2	1	—	—	2	6
May	1	3	1	—	1	2	8
June	—	3	1	2	4	1	11
July	—	2	1	1	4	—	8
August	—	2	2	2	1	—	7
September	—	1	1	—	1	—	3
October	1	2	2	2	—	—	7
November	—	4	1	2	—	—	7
December	—	—	—	2	—	—	2
Total	5	19	12	17	12	14	79
Number actually serving	31*	51	65	75	80	75 to May 22	

* Together with six who joined December 17, 1901. These figures naturally include a number of the same men in consecutive years. The total number serving was 171.

Like Chart 5, this table illustrates the fact that attacks of Mediterranean Fever display no special predilection either for the time of year at which mosquitoes are most active and numerous or for the months in which the largest numbers of fever cases are in residence. Once again the prevailing features are the lack of consistency in the various years and of relationship to any recognisable conditions.

It will be seen, for instance, that the system of isolation commenced in October, 1902, has had no effect on incidence, and this is even more plainly shown since the perfected isolation measures instituted in June, 1905. Nor has the shifting of the quarters of the staff from the little rooms in the near neighbourhood of the sick, under the eaves of East and West Blocks, described on p. 23, where they were located till about October, 1902, to a building some distance from the hospital proper, had any more effect in diminishing the number attacked.

Description of Quarters.—These consist of the two uppermost floors of a building (formerly the infectious hospital) projecting towards Calcara Creek from the south-western corner of the hospital grounds and about 80 yards distant from West Block. Built as it is alongside the cliff on which the hospital stands, it is considerably below the level of the rest of the establishment and is approached from it by the roof. The basement consists of dockyard storehouses. The upper floor is mainly taken up by a long dormitory with windows on three sides, one large one facing the present fever block. Another small ward on the lower floor, facing south, was used as a sleeping place until early in the present year. The large dormitory is partly divided lengthwise by arches, and at the northern end of the inner half a portion is screened off to act as a sleeping place for the night duty men. There are two cubicles at the south end of its outer half for the ward-masters. (See accompanying Plan, p. 54.)

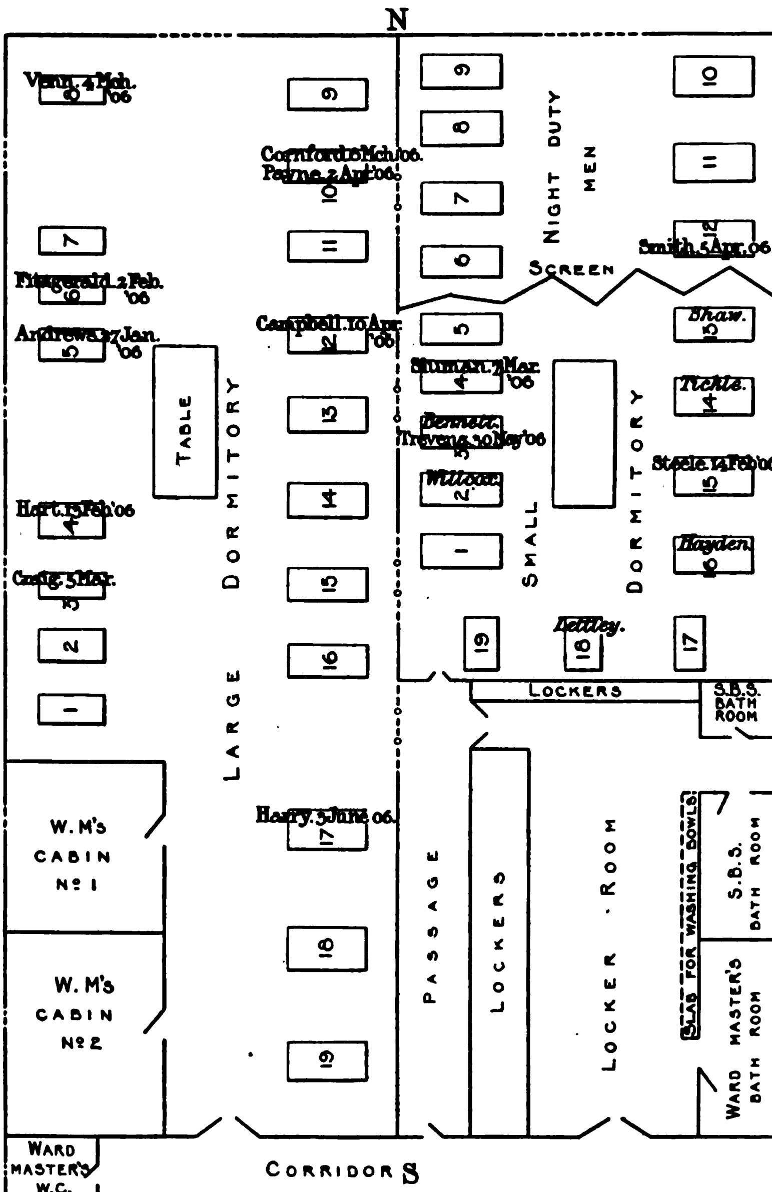
The sanitary arrangements conform with modern requirements and are in good order. No utensils are ever used in the dormitories for urinating, the latrine, which is entirely shut off from it, being invariably made use of. Four men are told off weekly for duties connected with the mess, two as cooks and two for cleaning and general duties.

When cases of Mediterranean Fever occur the practice has been to send bedding, but not the beds, for disinfection.

Mosquitoes are said to be very numerous in these quarters, and although few were sent for identification, the situation so near a large number of tanks, etc., found to contain larvæ, lends colour to this statement. A certain number of mosquito curtains were supplied for the first time in April, 1906, but only to some of the men.

Condensed milk has been used for a long time in the mornings, but till about the middle of April goats' milk, not infrequently unsterilised, was used in the afternoons for tea. The practice was then discovered and stopped.

The Outbreak among the Staff in 1906.—A considerable outbreak occurred in the early part of this year, commencing at the end of January. One case was put on the list in that month, three in February, five in March, two in May, and one in the early part of June. It had been noticed that mosquitoes were especially trouble-some during the winter, and it was found by Staff-Surgeon Whiteside, on examining the sleeping billets of these cases, that there was a marked grouping at the northern end of the outer side of the large ward close to the window facing the Mediterranean Block, the prevailing wind having been blowing in this direction. This, of course, suggested the possibility of aerial infection by dust particles or by biting flies. There was, however, another possible source of infection, inasmuch as Beds 9 and 10 E (*vide* Chart 6) were and had been occupied for a long time by two men who, without ever going on the



Showing the grouping of cases in the sleeping quarters of the Sick Berth Staff in 1905-1906.

1905 cases thus:—*Bennett*, 1906 cases thus:—**Hart.**

CHART 6.

list with fever, had been very seedy some year or more previously, and both of whom possessed high agglutinating power, in one case up to 1 in 300. One of these two subsequently went sick (Payne), and a second case occurred in a man sleeping in the same bed. The possibility of these men or one of them serving as the focus of infection, either by infected urine or by acting as the reservoir by which biting flies became infected, could not be ignored.

With the idea of eliminating one of these possibilities, the urine of both cases was plated out, but without recovering the specific micrococcus.

In order to collect evidence for or against the possibility of conveyance of infection from the Mediterranean wards either by dust or mosquitoes, Staff-Surgeon Whiteside kindly obtained, as far as possible, the sleeping billets of the cases in the previous year. As will be seen in Chart 6, these show an entirely different grouping and do not at all suggest this mode of infection.

Relationship to previous Attacks of Illness.—In 18 cases out of the total number, 78, the patients had previously been on the sick list within a month or two with what was diagnosed as some other ailment. In nine of these the disease was returned as catarrh, influenza, rheumatism, or simple continued fever, a fact which rather suggests that these were really the first manifestations of Mediterranean Fever. The following case affords evidence in favour of this. A.S. joined hospital in January, 1906, and at once went on the list with gonorrhœa from January 18 to February 9; he went sick again on April 5 with what was called influenza. On the 5th his blood gave a minus reaction; on the 7th, a doubtful 1 in 10. On the 18th he returned to duty apparently well, and on the 26th was vaccinated with dead *Micrococcus melitensis*, his blood being examined at the same time and found to react 1 in 50. On May 24 he again went on the list with developed Mediterranean Fever and reacted on May 26 1 in 100.

The remaining 8 cases were—gonorrhœa 2, chancroid 1, laryngitis 1, abscess 2, epididymitis 1, and anthrax 1.

It is an interesting consideration in the first place as to whether these cases were in any way connected with the subsequent attack, and if so, in what manner. There is considerable reason to suspect that of the first nine, some cases, at least, were the first manifestations, and this justifies to some extent the remarks made with regard to the unreliability of figures where the time element is taken into account.

In a large proportion, however, the fact of being on the list would mean the ingestion of milk, and, on the other hand, a certain amount of debility would be produced and lessen resistance.

Facts elicited by the Study of Individual Cases in Hospital Staff.—Eight of the Sick Berth Staff and one man belonging to the hospital guard were personally examined.

All of these men lived in adjacent quarters, the house where the guard were accommodated being just on the side of Bighi steps, opposite to the quarters of the staff which have already been described. The majority of these nine men went ashore occasionally, but five stated that they never slept out of their quarters.

Milk History.—Of the Sick Berth Staff, five admitted drinking milk by itself, a sixth had occasionally taken it with strawberries, but the remaining two denied having taken it except in tea. In forms sent in to my predecessor, information had been provided about eight other cases among the Sick Berth Staff. Of these, five admitted drinking milk, but one of them only in tea, while no details on this point were provided with regard to the remaining three. With regard to the man belonging to the hospital guard, which numbered 13, he had been in the habit of taking about a pint of milk daily, but said that he always heated it until a scum formed. According to his comrades, however, there was considerable reason to doubt the accuracy of this statement. Only 1 of his 12 messmates was in the habit of taking more than a very small quantity of milk, and that always in tea.

Mosquitoes.—Seven of the men had mosquito nets, but at least two had only lately obtained them. Five stated that they were badly bitten on arrival some time previously, but not latterly, two that they were occasionally bitten, and one not at all. The man belonging to the hospital guard said that there were numbers of mosquitoes about, but that they did not trouble him, although last year he suffered severely. He had a small net, but it only covered his face and hands, and was probably of little use as a protection.

Contact with previous Cases.—One man had, until six days before onset, been working for months in the Mediterranean Fever wards and six more had occasionally had cases of the disease to nurse, but not more than one or two, or for longer than a few days. In one case there was no history of contact with Mediterranean Fever cases.

Hand Disinfection.—One man, who had been nursing one or two cases in the officers' medical wards, admitted that he did not always disinfect his hands after dealing with possibly infective excreta, and two others were said to be casual and not unlikely to neglect the regulations with regard to this precaution. The others, however, all insisted that they were most careful about it.

No other case had occurred for months in the hospital guard, and the remaining men when examined all gave negative reactions. The only manner in which the patient was likely to have been exposed was as sentry in front of the fever block.

(c) *Mediterranean Fever occurring in the other Residences and Quarters.*

There are notes since January, 1902, of attacks in two nursing sisters, three surgeons, one chaplain, and four of the hospital guard.

Two out of the three surgeons were constantly engaged in laboratory work, and in both the infection was considered to have been acquired while so occupied. According to this, therefore, officers would not appear to suffer in any greater ratio than their fellows outside hospital. Although they must be regarded as far more exposed to the risk of contact infection or the attack of infected mosquitoes, there is no reason to imagine that they are more in the habit of taking milk than those latter.

(d) *Mediterranean Fever occurring in the Hospital Ship "Maine."*

As so many of the patients who develop their first attack in England or on passage home are conveyed in the "Maine," it seems well to indicate here the reasons for thinking that such persons have contracted the infection in Bighi before leaving Malta.

Although this ship is, on the whole, well fitted for the purpose for which she is used, no ship can possibly compare with a shore establishment as a hospital for cases in which infection may be spread by contact, and if this were a frequent method of propagation, the "Maine" ought to be a well-recognised centre.

She has been running since 1901, and has alternately been used as a hospital on the station and for the conveyance of invalids to home ports.

The Sick Berth staff, up to July, 1905, numbered 12 and a wardmaster, but since then have been increased to 18. As a rule they are drawn from home hospitals, and, as the majority are young attendants, a previous history of Mediterranean Fever is uncommon among them. Most of them sleep in their own quarters forward, but some in the convalescent ward in close relation at times to Mediterranean Fever patients.

Until March, 1906, it was customary for three to be on night duty in watches, one for each ward. Mosquitoes are said to be frequently troublesome in their quarters, but not much in the wards. The remainder of the crew number 96.

Accommodation and Routine.—There are two main wards, holding about 50 patients each, the cubic capacity per bed varying from 480 to 600 cubic feet. Ventilation, which is partially effected by exhaust fans, is said to be very satisfactory, but the latrines are situated before and open directly out of the wards, and if a door in the forward bulkhead of the latrine is open the air is driven into the ward.

There is no attempt at isolation of Mediterranean Fever, cases being indiscriminately mingled and no mosquito curtains used.

Everything is disinfected in cases of typhoid and tubercle, but on account of the numbers carried, the beds themselves are not always so treated in cases of Mediterranean Fever. Similarly, the stringent instructions with regard to hand disinfection by the staff in case of

typhoid are not made a point of in Mediterranean Fever, and no disinfectants are used for bedpans.

Milk Supply.—In January, 1904, an order was given that fresh milk was to be used when procurable, but it was not made use of to any extent and was rescinded in August of the same year, since which time no fresh milk of any sort has been used in the ship.

Employments.—From December, 1903, to May, 1905, she acted as a hospital for destroyers, and lay most of her time in Lazzarretto Creek. Previously to that her work varied between trips to England and employment on the station, and since that date she has exclusively been used for the former purpose. Up to December, 1905, she had made 12 trips home, and had conveyed in that time a total of 483 Mediterranean Fever cases and 736 other patients, these being on board an average of 10 days apiece. While on the station she has had under treatment 181 fever cases, with a total days' sickness of 3630, and in the corresponding period 881 cases of other illness, also for long periods. From these figures, it is evident that there was an abundance of infective material on board, even when lying in Lazzarretto Creek, in the near neighbourhood of innumerable breeding places for Acartomyia, and also that a large number of non-immune and debilitated individuals have been in close contact.

Whether or not cases which have developed at home after passage have actually been contracted on board, it is impossible to say definitely, but the following facts argue against it.

In a large proportion of the cases developing after leaving Malta in the "Maine," the onset is said to have occurred during the 10 days on passage in the ship.

Again, with the exception of two cases which occurred in August and September, 1902 (before fresh milk was prohibited), no records can be found of any definite case among her staff or crew. Nor was any patient whose case sheet was examined among the many admitted to Bighi from destroyers during the period in which the "Maine" was acting as hospital for them suspected to have contracted his disease on board.

This is a very different record from that at Bighi, and affords justification for considering the balance of probability to be in favour of their contraction there. In view of the large number of cases gathered together under disadvantageous circumstances as regards space, ventilation, and isolation, and with no special precautions, it also constitutes a decided argument against any form of contact infection.

(e) *Summary of the Evidence obtained in Connection with the Contraction of Mediterranean Fever in the Royal Naval Hospital, Bighi.*

The foregoing investigation may be held to have fairly conclusively proved the following points:—

(1) That a very considerable proportion of cases contracted the disease in Bighi.

(2) That the distribution of cases is very general, both as regards localisation in wards and the particular form of illness which acts as the forerunner, but that there is a special liability among surgical cases.

(3) That apparently this is to be explained by the fact that surgical cases provide the greater number of those patients who are resident for a long time.

(4) That there is no indication of place infection, nor does propinquity to the potential sources of infection appear to have nearly as great an influence in determining the subsequent development of the disease as duration of residence, while no definite relation can be shown either to the amount of infective material in hospital or to the particular season of year.

(5) In short, that little evidence can be obtained in favour of direct inoculation while in attendance on the sick, inoculation by biting flies, direct contact, or dust infection.

(6) The proportion affected, however, seems to vary to some extent with the amount of susceptible material in hospital in the shape of cases of other illness and with the absolute total of patients.

(7) There are occasional outbursts of epidemicity, however, which show no relation to any special condition, but under the circumstances (with an infected milk supply) it is difficult to banish the idea of the existence of a more than usually gross infection or of an equivalent absence of sterilisation. Even apart from the possible necessity of repeated dosage, the conditions of supply are such that long residence would favour the possibility of ingestion of infective milk. Finally, the direct evidence obtained about milk and, above all, the total cessation of cases since there has been no doubt about its sterilisation, are strongly in favour of its having been the infective agent.

II.—Analysis of Cases showing no very definite Connection with Residence in Bighi.

Table XXI.

Year	1902.	1903.	1904.	1905.	1906.	Total.
Doubtful hospital cases	2	6	7	3	—	18
Cases in hospital more than 3 months previously	5	6	1	4	4	20
Officers, ward room	39	20	16	18	7	100
,, gun room	43	16	15	9	7	90
,, warrant	5	1	—	1	2	9
Total	87	37	31	28	16	199
Maltese service men	7	6	6	8	8	35
Dockyard employees (English)	4	4	1	—	5	14
Men belonging to depôt ships in Malta	7	11	8	11	2	39
Cases giving no reaction or otherwise indefinite	—	5	2	2	2	11
Foreigners	—	1	—	—	—	1
No particular characteristics	81	85	89	98	47	400

III.—Occurrence of Mediterranean Fever among Officers as compared with Men.

Of the 471 patients who had previously been under treatment in Bighi for other illness, 21 were officers, 14 being ward room, 5 gun room and 2 warrant, while the list of cases having no obvious connection with treatment there (*vide* p. 60) includes 199 officers of various grades or 220 in all as compared with 1056 men. Officers therefore suffer at the rate of one to every six men. The relative proportion of officers to men in the Fleet, of course, varies slightly,* but may be put down at 1 to 16 and the incidence is accordingly very much greater among the former than the latter. But the most curious feature is the difference between them as regards previous hospital residence. Thus, of 220 officers only 21, or if cases among the staff are included, 25, give such a history, whereas of 1056 men, 450 together with 74 of the staff and 4 of the hospital guard, or a total of 528, enter into this category. In other words, it appears to be necessary for the man to go to hospital to contract his fever in about 50 per cent. of the cases, while the officer is enabled to do so without this in all but about 11 per cent. The explanation that at once offers itself is, that the officer is allowed to have milk in the ship

* Early in 1906 there were 846 officers in a total of 13,628.

and that the men are not, except when on the sick list, and that the officer is far more liable to take milk in various forms when ashore than is the man. Judging from personal experience, it would seem rather a difficult matter, unless one is constantly on the alert, to avoid taking in clubs and hotels in Malta raw milk in such various insidious forms as creams, meringues, sauces, ices, etc.

It might, however, be suggested that the officer is more exposed on account of his shore-going propensities, and in this there is a certain degree of truth. With the exception of the comparatively small number of officers who live ashore, however, the bluejacket is far more in the habit of sleeping there, more particularly as compared with junior officers, who contribute so many of the cases, and not only so, but he is likely to sleep in places more densely populated, more infested by mosquitoes, and where beds are not protected by nets as they are in most clubs or hotels. This is illustrated in the personal investigation of the movements of patients attacked by Mediterranean Fever as detailed on p. 100.

It may also be regarded as somewhat remarkable that the officer should be comparatively immune after residence in hospital and that this rather suggested the influence of the greater isolation which cabins provide there. Not only, however, has the small part played by propinquity to the fever wards been sufficiently demonstrated, but a good many officers must have been accommodated in rooms considerably nearer to the fever block than the men in the surgical wards for instance. It is distinctly curious, however, that in view of the large amount of milk allowed to officers they should so rarely be attacked after stay in hospital.

Table XXII.—Comparing the Ratio of Officers and Men respectively after Stay in Hospital.

Year	1902.	1903.	1904.	1905.	1906.	Total.
Number of officers exposed	92	100	108	75	17	392
Number attacked...	4	4	4	7	1	20, or 5·1 per cent.
Number of men exposed	1192	1058	1238	1406	244	5138
Number attacked...	92	81	82	163	27	445, or 8·6 per cent.

It is seen, therefore, that there is a very decided difference, but it is probably explained to a large extent by the next table, which

contrasts the duration of residence in the two cases. A point worthy of note is that the percentage of officers admitted for Mediterranean Fever to the total admissions of that disease is much higher than the percentage admitted for other illness, which affords further proof of their special liability to the former.

Table XXIII.—Contrasting the Duration of Residence in Hospital among Officers and Men admitted to Bighi for Illness other than Mediterranean Fever.

Days	Under 10.	10 to 20.	20 to 30.	30 to 40.	Over 40.
Duration of residence of officers from January, 1902, to end of first quarter, 1906	80	126	76	46	63
No. developing Mediterranean Fever	2	8	4	4	2
Duration of residence of men for 1905 and first quarter of 1906 (from Table VIII)	295	470	334	240	420
No. developing Mediterranean Fever	20	29	33	31	85

The difference shown here is only what might be expected, as with officers Mediterranean Fever itself is the principal disease necessitating a long stay in hospital. From venereal disease, which constitutes the bulk of such cases among the men, officers are comparatively free, and they are rarely admitted for hernia or similar operations. The number exposed, too, during months such as May, 1905, in which there was a special danger of contracting the disease and in which a very large proportion of the total apparently became infected, is altogether insignificant as contrasted with the number of men in residence at the same time, and this also would tend to a larger ratio among the latter.

The yearly returns are also interesting. In 1902 there were 91 officers attacked, in 1903 41, in 1904 35, in 1905 35, and in 1906 17. The first year, which provided by far the greatest number, was peculiar in that fewer men suffered than usual, and the Army figures were also unusually low. These facts are far more compatible with some strictly limited source of infection such as milk supply than with conditions such as dust or mosquitoes, which would act more generally.

IV.—The Connection of Outbreaks of Mediterranean Fever with Stay in Dry Dock or alongside Dockyard Wall.

For a long time such a connection has been a matter of common observation and has been frequently cited as a strong argument in favour of the mosquito-borne origin of the disease. This was therefore one of the questions which demanded enquiry. Returns were obtained and forms made out giving as far as possible the history of ships docking or alongside the dockyard wall since January, 1904, the cases occurring during this time, and also in the preceding and succeeding three months, and finally any points in the previous history of such cases which serve to throw light on their origin. The returns, except for the actual period in dock, etc., are not absolutely complete owing to the fact that several ships have left the station or recommissioned and that until about June, 1905, only patients under treatment in Bighi are included as a rule. For the most prominent examples they are, however, complete, and at all events may be considered so for the occurrence of Mediterranean Fever while actually in dock, or alongside.

Description of Docks and Surroundings.—Before entering upon the consideration of the evidence derived from these returns, it is as well to give a short description of the docks involved.

Nos. 3 and 4 docks are situated, one somewhat in front of the other, along the northern or Senglea side of French Creek below the high bastion wall which separates them from the thickly populated streets of Senglea. These docks accommodate the battleships and larger cruisers chiefly. According to the returns obtained, battleships were docked in No. 4 26 times, 1st class cruisers 5 times, and smaller ships 5 times. No. 3 took 1st class cruisers twice and the smaller ships 16 times.

Possible Reservoirs of Infection in the Neighbourhood.—No. 4 dock, being furthest down the creek, is in relation only to Senglea, the opposite Corradino shore being practically uninhabited. No. 3, some 250 yards further up, abuts at its top end on Cospicua near the Naval stores and the market, while Senglea adjoins it alongside. From Senglea there were notified, in 1904, 12 cases, in 1905, 13, and in 1906, 11, up to the beginning of October. For Cospicua the figures were 21, 17, and 8 respectively. The spot maps which have been made out show that fully half those in Senglea and the majority of those in Cospicua were located at a considerable distance from these docks. Although it is unfortunately true that the civil notifications cannot be depended upon, it would be rather singular, to say the least of it, if this comparatively small number of cases, very generally distributed both as to time of year and localisation, even assuming the notification of only a small proportion, were sufficient

to account by means of infected mosquitoes for the considerable outbreaks that have occurred in ships in dock, more particularly taking into consideration the small number of mosquitoes found infected in hospital wards crammed with acute cases.

The dockyardsmen, several of whom have been shown by Shaw to be suffering from ambulatory Mediterranean Fever, form another possible source of infection, but as work in the yard ceases at 5.30 p.m., only Stegomyia or Acartomyia would be likely to become infected from them. With regard to the question of infection being conveyed from one case to another in the ship, not only must it be remembered that, while ships are in docks, cases are usually sent to hospital on the first sign of illness, but the chronological sequence of cases in the majority of instances does not suggest this mode of infection, as is shown in the returns.

Nos. 1 and 2 docks are situated in line, wedged into a sort of triangle at the top of Dockyard Creek, and are absolutely surrounded by a crowded part of Cospicua at far closer quarters than either of the others. Accordingly the chances of infection should be greater here, but these docks are used principally for destroyers, the crews of which are usually hulked on these occasions, and they have not therefore been taken into account. The only ships of any size which are included in the returns are the "Harrier," torpedo gunboat, which was in No. 2 for June, 1904, no cases occurring, and the "Surprise," despatch vessel, in the same dock last December and January with a similar result, although in her case two patients sent into hospital for other disease contracted Mediterranean Fever while resident.

Evidence of the Presence of Mosquitoes.—There can be no doubt that the domestic species are extensively bred in the houses all round, but in order to investigate the sources in the near vicinity of the docks a survey was made in June, at a time when both Nos. 3 and 4 docks were occupied and mosquitoes were greatly complained of by the ship in No. 4. The electric light connections were being laid, with the result that there were several collections of stagnant water around both docks. No larvæ were found anywhere around No. 3, but from several pools near the other dock they were obtained, and from one pool Acartomyia were bred out. In addition to these artificial collections of water, larvæ were found at the base of several of the hydraulic capstans, of which there are six near No. 4 and one only near No. 3, and in the surface-water channel at the bottom of the subway around the former dock which was blocked in several places, thus giving opportunity for water to collect. All of these proved to be some variety of Culex.

On several occasions collecting boxes were sent to ships in dock to procure the adult insect for identification, but none were ever obtained.

After the survey had been made, various recommendations for

prevention were made in conjunction with Fleet-Surgeon Hardie of the dockyard, and these may perhaps have reduced the numbers, but owing to the proximity of the houses it is unlikely that any very great result would be obtained. It is interesting to note that neither of the two ships referred to had any cases then or about that period. At the same time it was noted that the presence of the refuse boats which were kept alongside the wall between the two docks attracted very large number of flies in the near vicinity of the ships.

Latrines.—There are a large number of these around both docks, and all seemed in very good order. Separate places are kept for dockyardsmen and naval people, but it is said that the latrines for the latter are occasionally used by the dockyardsmen. One latrine for dockyardsmen, close to No. 4, is placed above a store and involves mounting several steps, the result being that the ground at the foot is extensively used for urination.

Possibilities of Infection apart from Convection by Biting Flies.—It seems to be taken for granted by advocates of the mosquito theory that dock outbreaks are necessarily to be attributed to this method of dissemination. From what has just been said it can be seen that contamination of food or drink by flies is by no means an impossibility, and that inoculation while cleaning latrines is equally to be considered. In addition, however, to these possible sources of infection, it must be remembered that while ships are in dock, far more patients are sent to hospital than usual. The cases of the "Irresistible" and "Vulcan," quoted later, give illustrations of this fact. The explanation is that, while in dock, a ship is more than ever an unsuitable place for a sick man, the sick-bay, moreover, is often under repair, and also there is no latrine available on board. It is often regarded, too, as a favourable opportunity for sending patients for operation, while tonsillitis and other similar ailments are apt to follow the free use of paint, etc., in the ship, and a prolonged stay usually means a considerable increase in the number of venereal cases.

Other possibilities of infection are to be found in the presence on board of numerous Maltese dockyardsmen, whose ideas of sanitation and decency are crude in the extreme. It is not altogether infrequent to find that, when working down in the double bottoms, to avoid the fatigue of coming on deck, they have converted the part of the ship in which they are working into a temporary latrine. Instances of this have been obtained even from destroyers.

Facts shown by the Returns of Docking referred to.—The most striking characteristic about these is the absolute lack of consistency in effects produced by docking on the incidence of the disease. As a general rule, perhaps, a lengthened stay in dock or alongside appears to be followed by a considerable number of cases, whereas a short stay, no matter the season, does not seem to have such effect. On the other

hand, however, instances are observed, such as the 63-day stay of the "London" in January, 1904, where more cases occurred in the preceding three months than during the period of stay and the succeeding three months together. The "Formidable," exposed to practically the same conditions for a similar time, provides a considerable number of cases, and the "Bulwark," in a much shorter time, and earlier in the year, provides more than either. Again, the "Formidable," exposed for 124 days in the beginning of 1905, shows but half a dozen cases, whereas the "Implacable," at an earlier period of the year, with 132 days, shows about 20.

The best marked instance is to be found in the "Irresistible" in 1905, but the "Vulcan," although alongside nearly as long a time, a little earlier in the year, seems to have escaped more lightly than many ships exposed during the winter. This inconsistency in result would appear to point rather to something in the ship than in the docking.

Influence of Season.—The best marked example occurred in midsummer, but instances are numerous during the cold months. Therefore, although the tendency seems to be increased by long exposure in the summer, cold weather does not exhibit any inhibitory influence.

Docks Affected.—The majority of outbreaks have occurred in No. 4 dock, but this has been shown to be used for most of the big ships. The experience of the "Vulcan" in 1905 shows that the danger exists almost if not quite as much as in No. 3 dock.

Influence of previous Hospital Residence.—But more interesting than all this are the facts shown with regard to the influence of previous residence in Bighi. A study of the returns shows that in something like 50 per cent. of the cases the patient had previously and recently been there, and that of those who had not, a very considerable proportion indeed are officers. Moreover, in a number of cases they had actually been in hospital during all or a great part of the time the ship was in dock, and were therefore exposed to dock conditions for a shorter time than their more fortunate messmates.

The outbreak in the "Irresistible" provides an excellent illustration. This battleship, with a complement of 780 men, went alongside the dockyard wall on April 15, 1905, and into dock on June 19, remaining there until August 1, a total of 107 days, 41 of which were spent in dry dock. During the entire year she contributed a total of 32 cases of Mediterranean Fever, of which no less than 22 actually came on the list during this 107 days and 5 more in the subsequent three months. At first sight, therefore, no more admirable illustration of mosquito-borne infection could be adduced: a severe outbreak coincident with docking in a ship previously comparatively free, at the appropriate time of year, and, in short, all the necessary conditions. When, however, the history of these cases is enquired into in more detail,

a very different impression is left. Thus, one man went into hospital for hernia five days after docking, and contracted the disease while resident there; a second was living ashore at Castille Signal Station all the time, and was, in fact, temporarily borne on the books of the "Egmont." Yet another also developed the disease while resident in hospital for other illness, and in all probability contracted it there. Of the total 27 cases occurring in close relation to the period in dock, no less than 15 in addition to these three had recently been in hospital for other illness, although in two instances this was diagnosed catarrh and was possibly the first manifestation of fever. A sixteenth case was one of relapse. Of the eight remaining, three occurred among officers. Among the men, therefore, five cases only had no apparent connection with hospital, and of these, one went on the list eight days after first going alongside, and a second 81 days after coming out of dock. Not only is this the case, but if the dates of residence in hospital are examined, it is seen that the majority of these men were there for a large part of the 107 days, and that the period of exposure to dock influences was in one as short as three days, in one 17 days, and in four about 20. In certainly the vast majority it was very much less than the rest of the ship's company.

Fleet-Surgeon Woodwright kindly supplied a list of people sent to hospital for other diseases during the 107 days. This gives 55 men during this period as compared with three in January, nine in February, seven in March, and five up to April 15, thus giving a good illustration of the increased number sent to hospital which always, as previously stated, follows docking. Adding these together, 79 men are seen to have been in hospital since the beginning of the year, and of these 15, or 19 per cent., subsequently developed fever, whereas of their 701 longer exposed shipmates only eight, or about 1 per cent., did so during the same period, and three of them were officers. If this were an isolated incident it might be regarded as coincidence, but it is not so; throughout the return practically the same thing is met with. The "Vulcan," for instance, sent five men into hospital before March 21, 1906, when she went alongside, and 30 more during her stay of 84 days. Among these 35 men, 10 subsequently developed fever, while among the 414 having no recent hospital history only five, including one officer, developed the disease during the same period.

If the cause were to be found in what used to be described as some miasmatic influence to which only the weakest succumb, this could be understood, but it is difficult to picture infected mosquitoes choosing their material in this deliberate way, and the same objection applies to all forms of contact infection.

Altogether, the evidence would suggest that docking increases the incidence of the disease, principally by favouring residence in hospital, possibly in a limited number of cases by mosquito infection or con-

traction during sexual intercourse, more probably by contamination of food by flies, or inoculation by infective urine in latrines or parts of the ship. It suggests in addition, however, that it acts also by producing other illness which lowers resistance and acts as the spark to produce the explosion in cases where Mediterranean Fever is latent in the individual, or that it may do the same by the depressing influence of the heat and general discomfort met with while in dock, without the intervention of actual illness.

V.—The Possibility of a Connection between Attacks of Mediterranean Fever and Sexual Intercourse with Infected Persons.

That this disease may have some etiological connection with sexual intercourse with infected persons is a conception that has occurred to more than one student of its epidemiology, the thought being prompted by the frequency with which it is associated with a venereal history, and the investigation, therefore, of the chances of such a method of infection has been made a part of the enquiry from its commencement. The results of the experiments and laboratory investigations made this year have shown that there is no doubt about its possibility, and it is left for epidemiological investigation to show whether this can be regarded as a frequent method of contraction.

Evidence with regard to this may be derived from two chief sources, first, the study of cases in which the attack was either associated with, or closely preceded by, venereal disease, and, secondly, the facts as to the history of exposure to possible infection in those cases personally investigated. Two points brought out while studying the development of Mediterranean Fever in patients recently treated for other illness appear to have a bearing on the subject. Table VII, for instance, shows that there is a decided difference in liability between persons suffering from the initial and the later manifestations of venereal disease notwithstanding long residence in both. Another interesting feature consists in the large number of patients in whom the precedent disease is complicated by glandular enlargement, and in whom also any operation on the glands results in an outburst of fever. Much the most probable explanation of this is that these bubo cases are those who are on milk diet, and in whom especially debility is produced, but there is a remote possibility that the organism is set free from these glands.

Notes have been made of 105 attacks since January, 1902, which were either associated with or closely preceded by the initial manifestations of venereal disease. Of these, 13 were found on investigation to be relapses or sequelæ, and are omitted. The remaining 92 contribute 41 contracted in Malta, 24 elsewhere, chiefly Greece, the home ports, Crete and Egypt, and about 27 there is no information available.

Of those contracted in Malta, the interval between the date of exposure and the onset of fever symptoms was in 10 cases under one month, in seven under two, in 11 under three, in 11 between three and six, and in two over that time.

The following cases include all those in which the evidence at all favoured possible connection :—

1. H. T.—Placed on sick list June 29, 1902, with acute gonorrhœa, and on July 26 developed Mediterranean Fever.

2. G. A.—Admitted to hospital on July 2, 1902, with history of acute gonorrhœa, temperature and headache following after a few days' treatment. This persisted in hospital, and there was positive reaction on July 17.

3. W. C.—Contracted syphilis, primary, in Malta on June 3, 1902. On July 8 was placed on list with temperature and a bubo. This was opened, but typical pyrexia persisted, although reaction negative till September 25.

4. R. B.—Entered on sick list December 5, 1902, with gonorrhœa, cystitis, and fever which persisted after admission to hospital on December 16. Reacted on January 22.

5. G. V.—Admitted on April 18, 1903, with uncomplicated gonorrhœa, contracted in Malta on the 11th. Tenderness of instep complained of on 22nd, and next day the temperature rose. On May 1 he had pain in back and headache, and reacted on May 26. This man was the S.B. attendant in hospital, whose duration of residence before the onset of fever was the shortest of all those dealt with.

6. A. B.—Contracted gonorrhœa on April 4, 1903, in Malta, and on April 26 complained of pain in right ankle, hip and thighs. Reacted May 9.

7. W. R.—Contracted gonorrhœa on March 12, 1903, in Malta, and was admitted to hospital on the 21st with a perineal abscess. The latter was opened and the temperature fell, but again rose on April 7, with shivering, although wound was healthy. Pyrexia persisted till April 13. He was discharged May 13, and onset of Mediterranean Fever June 19.

8. E. M.—Contracted gonorrhœa in Malta on September 12, 1902, and was admitted to hospital on October 3 with epididymitis and pyrexia, which persisted with occasional exacerbations until 23rd. No change then till December 16, when onset of Mediterranean Fever symptoms. Reacted December 28.

9. G. R.—Contracted gonorrhœa in Malta on January 3, 1904, and was admitted to hospital on the 28th with pyrexia and pain in perineum. The temperature was high and had risen three days previously and he had rigors, nausea and headache. Nothing was found to account for perineal pain. He reacted on February 11.

10. T. D.—Contracted gonorrhœa in Malta on December 13, 1903. Onset of Mediterranean Fever symptoms on January 14, 1904.

11. W. D.—Contracted syphilis at the end of September in Malta and was admitted on October 29. Two days later complained of pain in wrist and had rise of temperature. Reacted November 10.

12. C. W.—Contracted gonorrhœa in Malta. Admitted June 15, 1905, complaining of pains all over and had gleety discharge which two days later became profuse. Reacted on June 20.

13. P. W.—Contracted gonorrhœa in Malta about July 3, 1905, and reacted on July 11. Stated, however, that he had been feeling ill since 1st.

14. E. E.—Contracted gonorrhœa on October 4, 1905, at Malta, and was admitted on 16th with pyrexia. Reacted on October 20.

15. J. S.—Admitted for gonorrhœa on June 4, 1906, and reacted on June 8.

16. N. T.—Contracted gonorrhœa in Malta about three weeks before going sick

with Mediterranean Fever, and noticed it two or three days after admission. Had been feeling ill, however, off and on for three weeks.

17. G. P.—Contracted gonorrhœa in Malta about middle of October, 1903. This was followed by orchitis and pains in hip and shoulders, and by temperature at nights. Admitted to hospital on November 17, and gave good reaction at once.

The following cases are quoted to show that the development of Mediterranean Fever symptoms is not confined to patients whose venereal disease is contracted in Malta:—

1. T. T.—Contracted gonorrhœa on May 3, 1903, at Portsmouth and put on list on May 11. Discharged to Malta hospital from "Porpoise" on May 21. Rise of temperature and pain along cord on May 29 and reacted on May 30.

2. J. H. N.—Contracted syphilis primary and gonorrhœa on December 13, 1903, at Canea, and on January 15, 1904, developed symptoms of Mediterranean Fever.

The above cases include all which could be found in which the dates were at all suggestive of a simultaneous contraction of the two diseases, and it will be seen that the evidence could not, by the greatest stretch of the imagination, be called anything but inconclusive, and, as they were all treated in Bighi Hospital, is in the large majority far more suggestive of their having been contracted there.

Facts Elicited from the Study of Individual Cases with Regard to the Contraction of the Disease during Sexual Intercourse.—Of 59 persons in whom it was possible to obtain information on this point, 42 denied that they had ever had intercourse on the station, six admitted to having done so, but not for months, four had recently done so, but in places other than Malta, while seven admitted recent intercourse in Malta itself. In one of these latter cases the patient remembered having been severely bitten on the eyelid by some insect, but this was the only case in which such a history could be obtained. The intervals varied from three to six weeks before onset.

This is not a point upon which negative evidence can be regarded as very trustworthy, but taking it for what it is worth, it is not suggestive of any large number being contracted in this way.

Section B.—PREVENTIVE MEASURES INSTITUTED AGAINST MEDITERRANEAN FEVER IN THE NAVY.

I. Methods of Prevention Undertaken in 1906.

Protection from the Attacks of Mosquitoes.—The experiments and investigations carried out in 1905 by the members of the Commission had been very suggestive of a mosquito-borne infection, and after the arrival of the military members of the Commission this year it was decided on their recommendation to isolate all military Mediterranean Fever patients in the long ward of Valletta Hospital, and to render this mosquito-proof.

It has already been stated that systematic oiling of tanks, etc., and the use of mosquito nets had been for some time an established

routine at the Naval Hospital, while isolation had been adopted since 1902, but it was thought that if, in addition, one of the wards containing patients suffering from other illness, and which had recently contributed several cases of the disease, were treated similarly, it would act as a useful control to this experiment of protecting the infective cases from mosquito attack in the military hospital. Accordingly, on April 26, this suggestion was submitted to the Deputy-Inspector-General, and was forwarded by him to the Admiralty, and subsequently approved, but, fortunately, up to the end of October the work had not been commenced, so that any diminution in incidence which has occurred in the Navy cannot in any way be attributed to this proposed experiment.

Disinfection of Patients' Effects.—On May 4 I made the further suggestion that the effects of all patients, whatever their disease, admitted to hospital, should be disinfected, in order to prevent the possibility of undiagnosed cases being overlooked, but this measure was found to be impracticable, and it was likewise impossible to carry out on board ship processes akin to the disinfection and evacuation of barrack rooms introduced this year.

Control of Milk Supplies.—From a naval point of view, therefore, the only prophylactic measures which have been undertaken consist in those directed to the more efficient control of the milk supply.

So far as the Naval Hospital is concerned, the first step in this direction was taken by Staff-Surgeon Whiteside. Suspecting from the condition of the milk on several occasions, after issue to the wards, that it had not been properly sterilised, he had it intercepted on its way from the kitchen on each day from March 31 to April 7, 1906, and a sample taken with all needful precautions, and conveyed to the laboratory. On March 31 and April 1 and 4 an organism corresponding in morphological and cultural characteristics to *Micrococcus melitensis* and clumping with Mediterranean Fever serum was successfully isolated. On this being reported to Deputy-Inspector-General Bentham, the requisite measures were at once taken by him to ensure that there should in future be no possibility of neglecting the instructions, already existing, with regard to sterilisation of milk, and it may be regarded as practically certain that since this date there has been no repetition of this.

On May 4, as information had been obtained that some of the Sick Berth Staff had been drinking unsterilised milk in their own quarters, notwithstanding instructions to the contrary, I wrote to the Deputy-Inspector-General drawing attention to the fact that only the milk for the hospital itself was sterilised in the hospital kitchen, the supply for the various residences and quarters being sent to their own kitchens and, presumably, sterilised there. In this letter it was urged that this multiplication of sterilising stations added greatly to the chances

of some of the milk escaping, and the suggestion was put forward that the sterilisation should be carried out at the main gate, and no milk admitted into the grounds until this had been effected.

This was approved in principle, though with some alterations in detail, and was later carried out, but from May 21 to June 1 any such procedure was unnecessary owing to a strike of the goatherds, which rendered obligatory the use of preserved milks.

As a further guarantee of sterilisation I suggested on May 16 the routine use in hospital of the ortol and peroxide of hydrogen test, which had been mentioned to me by Dr. Eyre, and on the return of the fleet on May 23 from the Piræus its use was likewise recommended in all ships through the P.M.O. of the flagship, and a general memorandum was promulgated to that effect by the Commander-in-Chief.

On July 3 the Deputy-Inspector-General had made arrangements for the further examination of the goats supplying the hospital, and for the issue of identification labels for them, but after some 60 samples had been taken the goatherds objected to anything further being done and returned the labels, whereupon the supply was very rightly discontinued, and preserved milk has been used exclusively ever since.

Milk in the Fleet.—During the absence of the fleet on manœuvres, in June and July, I made an attempt to examine into the sources of milk for officers' messes, and the enquiry was started with two large dairies which supply the greater proportion of the ships. The system upon which both of these obtained their milk was, judging from the description given, of the most unsatisfactory nature. For the regular supply apparently a certain small number of goat or cow owners were called upon, but for any extraordinary occasion, such as the arrival of the fleet, milk was often obtained from quite casual sources. One of these two dairymen entirely failed to persuade any of the people who supplied him to allow even samples of milk to be obtained. After much trouble and one ineffective visit consent was obtained in the case of one owner of a small herd at Sliema who helped to supply the second dairy. Here, however, of the total of 20 goats half were said to be pregnant or, for other reasons, not yielding milk, an assertion which could not be tested, as the animals were located in a small back street, and so intermingled with other herds that it was impossible for anyone but the owner to distinguish between them. The 10 samples obtained were examined by Zammit's test, and one which gave a good reaction was plated out in the laboratory and reported to have yielded *Micrococcus melitensis*.

Accordingly, on the return of the fleet on August 4, I sent a letter to the P.M.O. of the flagship for submission to the Commander-in-Chief, detailing the result of these investigations and the exceedingly

unsatisfactory conditions under which milk was supplied to officers' messes, and also giving a short summary of the facts known up to that time, which suggested milk as the vehicle of infection.

The following alternative suggestions were also submitted :—

(1) The absolute substitution of preserved for fresh milk in the fleet.

(2) The prohibition of the use in the fleet of milk obtained from owners who refused to brand their animals in an unmistakable manner, to give samples of milk or blood at any time, and to milk them only in certain places and certain times to facilitate inspection by a special officer.

(3) The provision and entire control of a special milk supply by the naval authorities.

On the arrival of the fleet on August 4 the Commander-in-Chief repeated the order that all milk obtained in Malta was to be boiled. It was then to be tested by the ortol test, and the completion of this process to be signalled each morning to the flagship.

Ice Creams.—It was discovered on the return of the fleet in October, owing to a question being asked by the Commander of one of the ships as to the possibility of infection through ice creams, that these were in some cases being purveyed on board by hawkers. The attention of the P.M.O. of the flagship was therefore drawn to this, and the experiments made this year in the laboratory, which would suggest that these must be regarded as under suspicion, were referred to, with the result that a general memorandum was issued prohibiting their sale on board and warning officers and men that their consumption was attended with some degree of risk.

From this account it can be seen that in the Naval Hospital the milk cannot be said to have been certainly sterilised before April 9, and that the Sick Berth Staff and residents may have taken small quantities unsterilised for a week or two later. With regard to the fleet supply, the ortol test, when made use of between May 23 and June 5, showed that in two ships at least milk has not been boiled as supposed, but ever since the departure of the fleet from Malta on June 5 it is probable, from the increased attention paid to it and the use of this test, that there have been very few, if any, occasions on which it has escaped sterilisation.

II.—Incidence of Mediterranean Fever since the Foregoing Measures were Instituted.

Incidence in the Fleet.

Table XXIV.—Giving the Admissions per Month since January, 1902, excluding Relapses.

Month.	1902.	1903.	1904.	1905.		1906.	
	In Bighi.	In Bighi.	In Bighi.	In Bighi.	Others.	In Bighi.	Others.
January	7	18	27	17	—	20	4
February	8	20	28	7	2	21	11
March	26	30	24	17	—	16	6
April	27	20	28	29	—	22	3
May	47	33	4	31	7	19	5
June	34	45	15	46	1	8	15
July	27	12	22	30	20	4	8
August	22	4	12	16	9	3	4
September	26	25	8	4	2	2	—
October	32	18	44	12	—	3	1
November	22	29	17	24	3	1	—
December	16	21	17	14	2	—	—

In connection with this table it must be first of all noted that the fleet has this year been very considerably reduced, and further, that one or two of the larger ships have spent some time in England while recommissioning, and have returned with almost new crews.

In the second place, most ships have been absent from Malta for an unusually lengthy period. From February 9 to April 19, May 4 to 23, June 5 to August 4, and from August 13 to September 30, almost the entire fleet was absent. In 1905 the majority of the fleet made a short cruise early in the year, and again left on June 17, returning about August 26 and remaining till September 6, when another cruise was made, lasting till September 30.

The diminution in the number of cases therefore to some extent supports the statement made by Shaw to the effect that Malta is the headquarters of the disease, and that in the Navy very few cases are contracted elsewhere.

Nevertheless there is considerable reason for supposing that these two facts by no means explain the total decrease.

Incidence among Persons Constantly Resident in Malta.—If, for instance, the figures for the stationary ships and hospital on the one hand and the dockyard employees and the naval Maltese admitted to Bighi on the other are contrasted, it is seen that the former, to whom the precautions above detailed with regard to milk apply, show a very

decided reduction in the number of cases of Mediterranean Fever, whereas the latter, among whom no special measures have been adopted, show no diminution.

Table XXV.—Contrasting the Monthly Occurrence of Cases in the Hospital and Stationary Ships, and the Dockyard Employees and Naval Maltese admitted to Bighi for 1905 and 1906.

Month.	Hospital and stationary ships.*		Dockyard employees.†		Naval Maltese.†	
	1905.	1906.	1905.	1906.	1905.	1906.
January	2	2	—	—	—	1
February	—	5	—	—	1	1
March	3	5	—	1	1	—
April	1	5	—	—	1	—
May	8	6	—	1	—	—
June	9	1	2	1	2	3
July	5	1‡	—	1	—	1
August	3	—	—	—	—	2
September	1	—	—	—	—	1
October	1	—	—	1	—	—
November	3	1‡	—	—	1	—
December	—	—	—	—	2	—

* Milk precautions adopted after April, 1906.

† No special milk precautions.

‡ Both these men were living ashore and victualling themselves. In the last case a distinct milk history was obtained.

Pointing in the same direction is the fact that since the return of the fleet on September 30 to January 13, 1907, only six cases have been notified from Malta, Gibraltar, and the home hospitals. Of two which occurred in October, one, a warrant officer of the "Bulwark," was originally admitted with symptoms of pleurisy and, although he gave a reaction shortly after, was regarded as a doubtful case. The second, a domestic, lived ashore and gave a definite milk history. A third case, occurring in November, is the man referred to in Table XXV as having been victualling himself ashore and as also giving a definite milk history, and the fourth case, which likewise developed in November, was an officer of the "Surprise" who went straight home in the "Maine." The date of onset in his case is given from Haslar as July 21. Two cases have been notified from the home hospitals, one being a man belonging to the "Diana" whose illness commenced in October, and the second a Ch. S. B. steward from Bighi who has been frequently sick with "rheumatism" and the onset in whose case is indefinite. He was admitted to Haslar in November.

A third fresh case was also notified from Haslar, but this illness is stated to have commenced in March, when he had been three months under treatment for bubo in Bighi. With the exception of the S. B. steward these cases are included in Table XXIV under the month of onset.

It will be seen from Table XXV that the dockyard and Maltese contribute no less than 10 of the cases since June, and as a matter of fact the persons under treatment for this disease in Bighi have for the few months preceding November been drawn almost exclusively from these sections of the Naval population.

When contrasting the incidence of the disease this year as compared with 1905, it must be remembered that the figures for the present year include cases which have developed while at home or on passage there, and also cases not sent to hospital, whereas in 1905, except in a very few instances, only those cases returned from Malta and Gibraltar are taken into account and practically none which have not been sent to hospital. Comparing the cases only which have occurred on the station, a total is given of 174 from June to December, 1905, as opposed to 47 for the same period in 1906.

But there is yet another way in which the cases this year may have been over-estimated, inasmuch as there are quite a number included in the returns in which there is justification for some doubt either as to the diagnosis or as to whether the attack was really the first manifestation of the disease. This applies to four cases occurring in one ship at the end of June and one in another ship about the same time, in which no reaction was present very shortly after discharge following a very brief illness. These cases are further referred to on p. 84. Two cases in June were diagnosed on clinical grounds alone, and one was admitted to be doubtful. An eighth case had been constantly on the list at intervals for months with rheumatism or febrile attacks. A ninth, although he gave a reaction in his ship up to 1 in 20, showed no trace either at Gibraltar or Plymouth hospital, and was returned from both as Fever, S. C. Another man had been notified from his ship as giving a positive reaction during a short febrile attack in July, 1905, and may possibly, therefore, have been a relapse.

Incidence of the Disease in Bighi Hospital.—Even more noteworthy than all this, however, is the alteration that has taken place as regards the incidence of the disease in the Royal Naval Hospital at Bighi. It has been shown that since April 9 the sterilisation of milk may be regarded as reliable. Chart 5 and Table VIII show that, of the patients suffering from other illness in Bighi during the first quarter of 1906, 28 subsequently, within three months of discharge, developed Mediterranean Fever, but that this has not occurred in a single person who has been admitted since. As a matter of fact, among patients

resident in Bighi and subsequently developing the disease, no one shows a later date of discharge than April 16, seven days after the more stringent regulations with regard to sterilisation came into force, and in that particular case symptoms developed within three days. No other individual suffering from an attack has given a history of previous residence subsequent to that date, and, simultaneously, *there has been a total cessation of cases definitely contracted while still in hospital.*

This contrasts markedly with 1905 and the first quarter of 1906. Yet Table VIII, which illustrates this, also shows that, although the number of cases of other illness was comparatively small, there were at least quite as many long residence cases admitted in the second as in the first quarter and, given corresponding conditions, a number should have contracted the disease. Nor can the diminution in the amount of infective material be put forward as the explanation, since Chart 5 shows that in April and May, although no cases were contracted, there were quite as many Mediterranean Fever cases in residence as in the earlier part of the year.

Although no definite case has developed in Bighi since the first quarter of this year, the following three cases are quoted because they represent the nearest approach to it that has occurred, and also because they illustrate the fact that, as stated on p. 246, a reaction may be present in Englishmen who have never shown symptoms.

R.P., stoker, was admitted to Bighi on September 5, 1906, with gonorrhœa, which was contracted at the Marsa on September 1. He showed no symptoms suggesting fever until the 28th, 22 days after admission, when he had headache and temperature lasting for two days. On blood examination, he was found to give a good reaction in a dilution of 1 in 10, but not in any higher dilution, and this condition persisted during the numerous blood examinations made before he was discharged, but without any recurrence of symptoms, and there has been no sign of illness up to the end of the year. He was in hospital during 1905 for a considerable time. Although it cannot be denied that this was possibly Mediterranean Fever, the progress of the case and the nature of the reaction is decidedly against this view and the medical officers of the hospital did not regard it as such. Another man admitted about the same time with typical symptoms of gonorrhœal rheumatism and iritis, whose blood was sent up more as a matter of routine than anything else, was found to present a precisely similar reaction. In this case there was no question of contraction in hospital, and the illness was also in all probability not Mediterranean Fever. An officer suffering from septic poisoning showed a similar reaction, but in his case a recent attack accounted for it. It cannot be said that these three afford any evidence for retracting the statement made above, that no definite case has been noticed since April.

Another point in favour of the view that the measures instituted this year have had an effect on the incidence of the disease is that while the Army ratio has fallen, no marked alteration is shown up to September among the civil population for whom no corresponding preventive measures have been taken.

Conclusion.—The reductions would therefore seem to have been greater than appears at first sight and the history, especially as regards Bighi, points strongly to the precautions taken in connection with milk as mainly contributing to this, while the evidence derived from a comparison of the ratios in the Service and civil populations argues in a like direction.

SECTION C.—PERSONAL INVESTIGATIONS.

I.—The Prevalence of Mediterranean Fever in Separate Ships During 1906.

Battleships.—All the battleships on this station belong to the same class and possess several characteristics in common. Accommodation for the men is not particularly good, and in bad weather they have to sleep in the lower parts of the ship where ventilation is very defective, but in this respect none of this class are as badly off as cruisers like the "Leviathan," which suffers far more severely from overcrowding. The men's latrines are on the upper deck, but the sick bay W.C., into which most of the infective excreta are emptied, opens directly out of the sick bay.

Milk Supply.—While at Malta, fresh milk was supplied to all these ships for officers' messes, and in the case of the "London," "Implacable," "Irresistible," and "Venerable" for the sick bay also. The "Bulwark" and "Formidable" used tinned milk in the sick bay, while the other two ships, the "Queen" and "Prince of Wales," left for England to recommission early in the year, and were for so short a time on the station that they are not taken into account. There were strict instructions with regard to the boiling of milk in all cases, but in at least one ship, when the ortol test was first made use of in May, milk, supposed to be boiled, both for gunroom and wardroom, was shown to give the characteristic reaction.

Disinfection in Cases of Mediterranean Fever.—The process adopted varied greatly in different ships. In the "Irresistible," which contributed more cases than any other ship, not only were the excreta and also the sheets and bedding disinfected, but the W.C. was fumigated, while in the "Implacable," which also contributed a considerable number of cases, no very special precautions were taken in this direction. In the "London" everything was disinfected, and in the "Bulwark" only the excreta and sheets, etc., but not beds.

Hawkers of food stuffs were only allowed in one of these ships and in that case it was confined to fruits and aerated waters.

H.M.S. "*Bulwark.*"—This ship is the flagship of the Commander-in-Chief and has an average complement of about 829 men; she was recommissioned on January 3, 1905, and most of her crew therefore have been from one to two years on the station.

Movements.—She was continuously alongside the dockyard wall or in dry dock in Malta from October 31, 1905, to February 5, 1906, and five days later left with most of the fleet for a cruise during which she touched at Gibraltar, Genoa, Aranci Bay, Naples, and Corfu, and returned to Malta on April 19. From May 2 to 5 she went to Platea and left that place for Phalerum Bay on the latter date owing to the Turkish frontier dispute, returning again to Malta on May 25 and remaining until June 5, when she again left with the rest of the Fleet for the grand manœuvres, her headquarters then being at Gibraltar. Another short stay was made at Malta from August 4 to 13 and a cruise up the Adriatic and to Argostoli followed, a final return to Malta for the winter being made on September 30.

Incidence of Cases.—Three first attacks and also three relapse cases occurred in January, one in March, three in May, one in June, one in July, and two in October. The principal point of interest about them consisted in the grouping that was exhibited. One patient, who became ill on January 19, belonged to No. 43 Mess, a second three days later came from No. 47, two tables further along on the same side of the ship, but the first of these was in Bighi, from November 13 to December 8, with gonorrhoea, and probably contracted the disease there. Another, on March 19, belonged to No. 45, situated between these two, and this man had been in hospital from February 1 to 9 with what was diagnosed as influenza, but may have been the initial manifestation of Mediterranean Fever, as he had given a doubtful reaction in 1 in 10 dilution while there. A second man from Mess 45 went sick on May 8; he also had been in hospital from January 24 to February 9, but in this case with ulcer of the foot, and had very likely contracted the disease there. On June 2 yet a third man from Mess 45 became ill. One curious feature about these cases was that two showed unusual symptoms in the shape of purpuric eruption and swelling of the ankles. None of them had been ashore more than once or twice in Malta recently, but up to February 5 the ship had of course been alongside the dockyard. The marked grouping is certainly suggestive at first sight of contact or mosquito-borne infection, but, with regard to the latter, the sleeping billets of these five men were widely separated, and in two cases at least there were decided possibilities of infection while in hospital. With one exception the three relapse cases mentioned were far removed from these messes, and this exception was in a mess on the opposite side of

the ship. All the affected messes were close alongside the seamen's galley, but the officers' galley where the fresh milk would be taken was further aft in the next compartment.

It is likewise interesting to note that from the end of May, when the ortol test was adopted, up to December 7, only four cases occurred. Three were living ashore, one an officer, two domestics, and the fourth (also an officer) appears to have been a somewhat doubtful case.

The apparent dependence on stay in Malta is also to be noted, no case having occurred after July 17 until return in October.

H.M.S. "London."—This ship has an average complement of about 740, and as she was commissioned on April 6, 1905, the majority of her crew are also in their second year on the station.

Movements.—On January 4 she left Malta for a cruise to Genoa, Civita Vecchia, and Naples, arriving at Malta again on January 31, and next day going alongside the dockyard, where, or in dook, she remained until April 24, when she moved out to moorings in Grand Harbour. From May 5 to 23 she accompanied the fleet to Phalerum Bay, and from June 5 to July 28 to Lagos for manœuvres. On the latter date she again returned to Malta and remained till August 6, when she left for the Adriatic cruise, finally returning on September 30. This ship was, therefore, during the earlier part of the year, longer exposed than the majority of the others to the possibility of infection at Malta.

Incidence of Cases.—The first case of the year fell ill on January 24; he had recently been in hospital from October 14 to December 1 with sore throat and rheumatism. The second case followed on February 4, three days after going alongside the dockyard. Nine days later a third man first felt ill, and on February 17 a fourth. The next case began exactly a week later, on February 24, and the next, a marine gunner, on March 13. Both these latter were discharged cured at the beginning of April and rejoined the ship. The next case that occurred had been in hospital from January 1 to February 9, and was put on the list on March 31. On April 24 another marine gunner began to feel ill; he had been messing with the man already mentioned as having been discharged cured from hospital since April 6. A Maltese stoker who lived ashore at Cospicua began to ail about May 12, and the next case, an ordinary seaman who had been in hospital for two months until April 7 with psoriasis, commenced to feel ill on May 14. Since that time there have only been two rather doubtful cases and one attack in a Maltese domestic.

The two doubtful cases were the captain's steward—who was sick on board from July 18 to 28, and gave a reaction with a dead culture, but in whom no trace of a reaction could be obtained when his serum was examined on August 1 in the Commission Laboratory—and a midshipman, who was sent on June 23 to Gibraltar Hospital for appendicitis, and was invalided as Mediterranean Fever, but the diagnosis was made on clinical grounds, no reaction having been obtained.

The Maltese domestic became ill a few days after the ship left Malta in August.

Of the 13 possible cases, therefore, three had recently been in hospital and two were Maltese, while of the others two were doubtful. Six occurred in close relation to the period during which the ship was in dock or alongside, of whom only one had been in hospital. Two of the others, however, were marines, and it is to be noted that the marines of this ship were at Ghain Tuffe Rifle Range from February 12 to 27 and March 3 to 12, and that one of the two attacked had been sleeping there up to March 10. Four of the 13 patients attacked were marines, but these cases were widely separated in point of time, and with the one exception already noted there was no attempt at grouping.

Possible Sources of Infection.—The blood of 28 of the permanent Maltese was kindly sent by Fleet-Surgeon Hadden to the laboratory, and one was found to react up to 1 in 50. A man who was the manager of the canteen began to ail about April 1, and eventually died at his home ashore of what was returned as Mediterranean Fever; he may have been ill for some time on board. The blood of both the men who were discharged cured from hospital was also examined, but neither gave a reaction.

H.M.S. "Implacable."—This ship has a complement of 742 men and arrived on the station on September 17, 1904, after recommissioning, and since that time has had over 20 cases of Mediterranean Fever, so that she has been one of the ships more severely attacked.

Movements.—She arrived at Malta from Corfu on January 5, 1906, and remained at moorings in Grand Harbour until February 10, with the exception of 14 days in dock, from January 25 onwards, when she left for the Lagos cruise. She returned to Malta, however, on March 13 to have her fire control fitted, and was in dock and alongside for that purpose for 24 days. On April 6 she left for Corfu, returning on the 19th, and during this trip took away the six dockyardsmen who were at work on fire control. She only remained four days on this occasion and then went to Platea until May 5, when she accompanied the fleet to Phalerum Bay. On her return she spent five days at Marsa Sirocco, and finally reached Grand Harbour on May 30. On June 5 she again sailed for the manœuvres, and while absent on this occasion proceeded to England to recommission, and since that time has contributed no cases of Mediterranean Fever, so that all remarks deal with the old commission.

Incidence of Cases.—Four cases were admitted from this ship on January 1, of whom one had just previously been in hospital with rheumatism, and one was a Maltese domestic. The onset in all was about the middle of December. A fifth case became ill on January 14, and another on February 20, but this latter patient had been discharged

from hospital on December 13, after enteric, and had probably contracted the disease there. He was an engine-room artificer. While the ship was at Malta, after March 13, two men, one the sick berth steward, suffered from attacks, the diagnosis being later verified by blood examination in the Commission Laboratory. The sick berth steward did not go on the sick list. Both had quite recently been in hospital. On the return of the ship from Corfu on April 19, five more cases were sent to hospital, but one of these was a relapse in a man who had rejoined the ship on March 13. Three of the remaining four had been recently in hospital, and probably contracted the disease there, the dates of onset being March 24 and April 3 and 16 respectively. The fourth case was an artificer belonging to the same mess as the first one, and the date of onset in his case was also April 16. Two gun-room artificers next became ill on April 23 and 25 respectively; the second had, five months previously, been in hospital with an ulcer.

Of the 14 cases in this ship, therefore, seven had been in hospital within three months of other illness, two were officers, and one a Maltese. Two belonged to the gun-room and two to Mess 55, one each to Messes 57, 59, and 61. The others were widely scattered.

Possible Sources of Infection.—The relapse case was on board from March 13 to April 19, and after his second admission on that date his urine was plated out on more than one occasion both at Bighi and in the Commission Laboratory, but without recovering the Micrococcus. Two other men were suffering from the disease on board, one becoming ill on March 13, the other on March 17, and one of these was not on the list. Six dockyardsmen were on board, living in a casemate, from April 6 to 19, and had been working on board since March 13. The blood of five of these was obtained, and one gave a reaction in both 1-per-cent. and 2-per-cent. dilution, but not a very marked one, and one other in only 1-per-cent. dilution. Eight dockyardsmen, including three of the preceding, were working on board from April 21 to May 29, but none of these gave a positive reaction. Of 11 who were left in the ship on June 5, all but two had been included in the previous parties, the man who gave the reaction in both dilutions being one of them. Neither of the two fresh men reacted. Twenty-eight of the permanent Maltese in this ship were also examined and one only was found to give a reaction, this being the domestic who was admitted to hospital for Mediterranean Fever on January 1.

It is evident, therefore, that in this ship there were an unusually large number of possible sources of infection, while a certain degree of grouping was noted, but the fact that so large a proportion of those who were not officers or Maltese had recently been in hospital rather discounts the value of this as an evidence of contact infection. The case which pointed most strongly in this direction was the second artificer, who

had been working with the party of dockyardsmen, two of whom reacted.

H.M.S. "*Irresistible.*"—This ship, which also has an average complement of about 740 men and was in her second year on the station, suffered during 1905, as already detailed at p. 66, more severely than any other battleship, principally during a long stay in dock.

Movements.—From January 1 to 27, 1906, she was cruising between Patras, Platea, and Corfu, and on the latter date arrived at Malta, where she remained moored in Grand Harbour until February 10. She accompanied the rest of the fleet for manœuvres at Lagos, and later went with the flagship to Genoa, Aranci Bay, Naples, and Corfu, returning to Malta on April 19, and remaining in Grand Harbour till April 30, when she left to carry out firing, and went on with the others to Phalerum Bay. She returned on May 22, but left at once for Marsa Sirocco for two days, and on coming back to Grand Harbour went into dock from May 28 to June 1. Like the other ships, she left again on June 5, but returned on July 29 and once more went into dock for a further period of six days, leaving on August 6 for the same cruise as the flagship. It will be seen, therefore, that her men have had comparatively few opportunities of leave in Malta since February.

Incidence of Cases.—Two patients, a warrant officer and a stoker, became ill on February 20, 10 days after leaving Malta, and a marine gunner the next day. All three had been quite recently in hospital, and probably contracted the disease there. Three more were sent to hospital on her return to Malta on April 19, one of these being a relapse case, and the other two having become ill on April 1 and 16 respectively. Both had been in hospital, one until the ship left Malta, while the other had not been discharged till February 19, and had waited some time in the "Egmont." In the first case, therefore, the onset occurred some 40 days after departure from Malta. The next case, an officer who had been in hospital for operation on the knee joint, first felt ill on April 12, a month after discharge; he had been living ashore during the interval.

Up to this time, therefore, every case, without exception, had recently been in Bighi suffering from other illness, but after this, although this ship was the only one which returned any considerable number of cases subsequent to the departure of the fleet on June 5, only one of these had previously been in hospital, and he before April. A marked grouping was, however, met with in this second series of cases. The first of these, a chief petty officer, began to feel ill on June 2, but was not placed on the list till after she left for the cruise. A second man, belonging to Mess 26, which was separated from the chief petty officers' mess by a water-tight compartment, communicating by a door, first began to ail about June 6. An able seaman, living on a different

deck, was the next to feel ill, the onset in his case being about June 23, and he gave a history of hospital residence from February 3 to March 21. A fourth man, belonging also to Mess 26, first had symptoms on June 26, and next day a chief petty officer with his mess in quite a different part of the ship also began to ail. The day after this a chief stoker, who had up to June 21 also belonged to Mess 26, was put on the list, but this man said he had been feeling off colour for months. The last man belonged to a different mess altogether, and his symptoms began on July 14, or rather more than a month after leaving Malta.

Since that time only one case has occurred, the sick berth attendant, who first complained on August 8, two days after leaving Malta on the next occasion. This man was on the staff at Bighi until May 4.

Mess 26 and the chief petty officers' mess next to it were closely adjacent to the sick bay, so that of the eight cases occurring after June 5 no less than five came from one very limited portion of the ship. Propinquity to the sick bay offers, therefore, a possible source of infection, but the man who first felt ill did not go on the sick list as soon as the second, so that two out of the five occurred before there was any known source of infection there.

It is also a curious fact that four out of these eight cases were only ill about three weeks, and that when their blood was examined in the Commission Laboratory on August 1, very shortly after their discharge from the sick list, not one of them gave the faintest trace of a reaction. Surgeon Macleod, who was kind enough to give information on the subject, states that the symptoms were in all cases quite characteristic, that the reaction was undoubted in each case, and was repeated more than once, and that a control showed no reaction. The culture was, however, an old one, and as none of the patients have since shown any sign of recurrence of symptoms, some small amount of doubt as to the nature of the illness may perhaps be permitted. Anything suggesting criticism of the results obtained by competent observers who have, moreover, had the advantage of studying the actual symptoms is to be avoided, but as the culture used was an old one it may at least be regarded as rather a curious coincidence that no less than four cases occurring at the same time should be of such short duration, have no sequelæ, and within a month fail to give a trace of agglutination even in low dilutions. At the same time the fact that the remaining cases, which were more severe and necessitated invaliding, have all been confirmed by examinations made at the home hospitals must be regarded as evidence in favour of the four specified above being cases of the disease.

There was another possible source of infection in this group of cases, inasmuch as several dockyardsmen who were in the ship during this

particular cruise fitting fire control were accommodated in the casemates just alongside these messes. Accordingly, on the return of the fleet, the blood of six out of the total of seven of these men was obtained and tested, but no reactions were obtained. The blood of 28 of the permanent Maltese on board was also obtained and tested, and one was found to react. Of the five men composing the group, two slept in their messes, and the sick berth attendant in the sick bay, the rest elsewhere. Once again, therefore, the evidence, on the whole, points to some cause operating in the daytime rather than at night.

H.M.S. "*Venerable.*"—This, the flagship of the second in command, has been on the station since September, 1905, and her average complement is about 770.

Movements.—She was at Naples on January 1, 1906, whence she proceeded *viâ* Port Augusta to Malta, arriving on January 9, and remaining at moorings in Grand Harbour till February 10. On that date she left for manœuvres at Lagos, but did not return with the rest of the fleet, as she proceeded on March 8 to Chatham to receive a new admiral. She left England on March 30 and arrived at Malta, after calling at Gibraltar, on April 7. Three days later she went into No. 4 Dock, and remained there or alongside the wall till June 5, when she left for manœuvres. Her later movements correspond with those of the "Bulwark."

Incidence of Cases.—Very few cases are recorded this year. One man developed the disease while resident in hospital on January 7. A midshipman was sent to hospital on January 19 for what was at the time diagnosed influenza, but as he showed a doubtful reaction and later developed Mediterranean Fever it is probable that this illness was the first manifestation of that disease. An E. R. artificer who was sent to hospital on April 10 for removal of tonsils developed suspicious symptoms nine days later, and once reacted in a dilution of 1 in 50, but this was the only positive result in numerous examinations, nor could the organism be recovered from his blood or urine. This case has not been included in the returns. A fourth man, an ordinary seaman, developed the disease on April 18; he had been in hospital till March 27, and just before discharge showed suspicious symptoms, but gave no reaction. The disease was probably contracted there. Since then the only case that has occurred was another ordinary seaman who first felt ill on June 29, 24 days after leaving Malta. Very little information is available about this case.

H.M.S. "*Formidable.*"—This ship provided no case throughout the year. She belongs to the same class as the others and recommissioned on October 1, 1904, her complement averaging about 740 men. Since commissioning she has only had about seven cases, although in 1905 she was in dock or alongside for a period of 124 days. Her last

case occurred in December, 1905, and she remained on the station till August 13, 1906. It is interesting to note that her medical officer is inclined to ascribe this immunity to the practice of rarely sending a case to hospital except for invaliding. He further stated that tinned milk only has been used in the sick bay, and that mosquitoes were rarely seen.

H.M.S. "*Queen.*"—This battleship went home to recommission in April, and since her return has not provided a single definite case, although one officer sent to Gibraltar Hospital was so diagnosed, but only on clinical grounds. Before her return to England four cases had occurred, of whom two had previously been in hospital.

H.M.S. "*Prince of Wales.*"—This ship also left the station in May to recommission, and remained there till well on in the year. She has not provided any cases since her return, but before going had had two, one of whom had been recently in hospital, while the other was contracted while resident there.

CRUISERS.—There are four first class and three second class cruisers on the station, all the latter being sister ships. The first class cruisers are all recently built and well up-to-date in equipment, but the "Leviathan," which is much the largest of the four, carries more men than any ship on the station and suffers much more from overcrowding and defective ventilation. Ships of this class nearly always have a heavy sick list, while wounds are apt to become septic, and there is much sore throat.

The accommodation in the "Lancaster," "Suffolk," and "Carnarvon," is much superior, and the latter, which is larger than the other two, is fitted with a bakery and the most up-to-date arrangements for cooking. The three second class ships are also very comfortable, and the accommodation is on the whole good, and ventilation, owing to their smaller size, is more satisfactory. They are employed on the outlying parts of the station and are comparatively rarely at Malta. The latrines in all these ships are on the upper deck, and in all there is a W.C. opening directly out of the sick bay, into which most of the excreta from the sick are discharged.

Milk Supply.—Fresh milk has been used for officers in all these ships except the "Suffolk," the ward room officers of which ship, I believe, voluntarily gave up the use of it shortly after arrival in April. It has also been made use of in the sick bay in all but the "Suffolk" and "Venus." In one of these ships at the end of May it was found unboiled, despite orders to the contrary.

Disinfection.—There have been no cases in the "Suffolk" and "Lancaster" since recommissioning, and no information is therefore available on this point. In the "Venus" during her last commission, besides the ordinary measures relating to excreta, clothing, etc., after the occurrence of a case of Mediterranean Fever, the fixtures in th

sick bay were removed, the place scrubbed with perchloride of mercury lotion and then repainted. In the "Carnarvon," "Diana," and "Minerva," excreta, clothing, and bedding were disinfected, but in the "Leviathan" only the excreta.

Hawkers of food stuffs were only permitted in the "Leviathan," which has contributed practically no cases.

H.M.S. "*Leviathan.*"—This, the flagship of the cruiser squadron, has an average complement of 908, and has been on the station since December 12, 1905.

Movements.—She was in Malta until February 10, being alongside the dockyard until January 22. She accompanied the fleet on February 10 and returned to Malta again, on April 20, till April 30. On May 5 she merely returned in order to proceed to Phalerum Bay. On her way back from the latter place she called at Port Said and Alexandria, and only arrived in Malta on May 28, leaving again on June 4. She was one of the four ships that came in again on July 28, and she sailed for the Adriatic cruise on August 3, not returning again till September 30.

Incidence of Cases.—With the exception of one Maltese domestic who had a relapse on December 18, 1905, the only cases have been two which occurred in March in men who had been in hospital and were waiting in the "Egmont," one stoker who first felt ill on April 24, and a ward-room officer who noticed his first symptoms on June 19. There was no possibility of connection between any of these.

H.M.S. "*Carnarvon.*"—This ship has a complement of 636 and has been on the station since June, 1905. She was in Sliema harbour in dockyard hands until February 10, and then proceeded on the Lagos cruise and afterwards by herself to Marseilles and Greece, not returning to Malta till May 3, and then only stopping two days before leaving for Phalerum Bay. She came back again on May 25 and went into dock from June 1 to June 5, leaving on that date for manœuvres. She also returned on July 28 and remained till August 4, her subsequent movements corresponding with those of the "Leviathan." This ship was, therefore, almost altogether absent from Malta between February 10 and October 1.

Incidence of Cases.—Three cases occurred in February, one on the 10th and two on the 20th; all had recently been in hospital. A relapse case occurred in one of her Maltese on February 25, and on March 15 a stoker who had been discharged from hospital on February 9, after an attack of gonorrhœa, also first felt ill. These were all the cases that occurred during her first absence from Malta, but after the short stay she made in June, one case felt ill on the 21st, 16 days after leaving, and a second on July 11, or a little over a month. A third case was put on the list on July 15 with rheumatism,

but was found to have Mediterranean Fever after admission to Bighi on July 30. This man had been there previously from November 3 to January 31 with enteric, and since discharge had already been on the list three times for periods of a few days with febrile attacks and rheumatism. The chances are therefore in favour of this attack having been originally contracted in hospital and of its having existed since March, at which time he had his first bout of sickness. One more case occurred in this ship on August 8, four days after leaving Malta, the patient being a gun-room officer. The attack was not a severe one. Of the total of eight, therefore, five were probably contracted in hospital and one was an officer. The sleeping and messing billets of the last cases were in entirely different parts of the ship and there was no reason to suspect any relation between them.

H.M.S. "Lancaster" and "Suffolk."—Both these ships have complements of about 680 men, both recommissioned at about the end of March, and neither has contributed a single case since arrival on the station. They were practically always with the fleet, and have therefore been in Malta on three occasions for 10 days or so previous to October.

H.M.S. "Venus."—This ship has a complement of about 419, and has been in commission since February 7, 1903. She left the station early in May to pay off, and did not return till August 4. She has been largely employed in Cretan waters. She was in Malta from January 1 to 31, and up to the 24th was in dock. She then left for Crete and remained there till May 1, when she returned to Malta and a week later sailed for England to recommission. She came back to Malta on August 2 and remained till the 19th, when she proceeded to Port Said and was there until November.

Incidence of Cases.—No case had occurred in this ship from July, 1905, until after she had been in dock. Then a Marine private went on the list for three days on January 21 and again on March 27 for 51 days; a second Marine was put on the list on January 29 and was 59 days under treatment. A third Marine first complained on February 12, and a fourth on April 6, and finally an able seaman was admitted to Haslar on May 17. At first sight, therefore, this would appear to give an excellent illustration of the effects of docking, but a more detailed examination does not bear this out. First, the Marines were at Ghain Tuffieh rifle range from January 11 to 27, or rather more than half the time the ship was in dock, and, as a matter of fact, the first case was sent in from there, and the second went sick two days after returning. The third case had been in Bighi from October 10 to November 13, 1905, with what was returned as functional heart disease, but as he gave a doubtful reaction during this stay, and the course of the case rather suggested Mediterranean Fever, this may have been the first manifestation of that disease.

This man was a ward-room servant and had drunk milk, probably unsterilised, on board. The able seaman was in hospital for the whole of January and was therefore not at all exposed to the possibility of infection in dock. This effectually disposes of docking as a factor in the causation of this group of cases.

The rifle range at Ghain Tuffieh is so isolated that the presence of infected mosquitoes is most improbable, and in fact mosquitoes are said by the officer in charge to be practically non-existent there. The possibility of contact infection from the third case, who may have been the subject of the disease all the time, cannot be altogether ignored, but, unfortunately, neither of the first two cases were seen, and no information could be obtained with regard to their relation to him.

Since the ship recommissioned there has been only one case, an officer who was discharged to the "Egmont" on August 18 to await passage home, and left on August 26 in the s.s. "Formosa." He complained of illness the day before leaving and died in the Seamen's Hospital, at Greenwich, on September 26, of Mediterranean Fever.

H.M.S. "*Minerva.*"—This ship commissioned in June, 1904; she has an average complement of about 420. She was in Egyptian waters for the first five months of the year and only arrived in Malta on June 1. She went into No. 3 Dock from June 8 to 15, leaving on the latter date for manœuvres. Mosquitoes were much complained of while in dock. She again arrived in Malta on July 24 and on the 30th went alongside the dockyard for some days. On August 20 she sailed for home to pay off.

This ship will be seen to have a larger proportion of infected persons among her Maltese than any other examined, and she has also spent a good many days in Malta during the hot months. She has not, however, contributed a single case of Mediterranean Fever.

H.M.S. "*Diana.*"—This ship has an average complement of about 400 and was commissioned on September 30, 1904. She was lying in Egyptian ports and Akaba in the Red Sea all the first part of the year until May 22, when she sailed for Malta, arriving on June 1 and going into No. 4 Dock from June 6 to 15, when she also left for the Atlantic manœuvres. Mosquitoes were more complained of in this ship than in the "Minerva." She returned to Malta on July 24 and August 9 for two short periods, of two and five days respectively, before the Adriatic cruise. Her last stay at Malta dated from September 14, and three days later she went alongside the dockyard until October 9, finally sailing for England to pay off on October 12.

Three cases occurred on board in the latter half of last year, but the only one in the first half of the present year was the case which is given in detail on p. 246. The next case, the master-at-arms, began to feel ill about July 19, or some 35 days after leaving Malta and

coming out of dock. He had been ashore at Gibraltar, but not elsewhere. A third case first complained on June 22, but this is a doubtful one, as his blood gave no reaction after leaving the ship. A fourth case has been returned from Plymouth hospital as commencing on October 10, but no further details are available.

SMALL SHIPS :—

H.M.S. "*Barham.*"—This ship, a third class cruiser, arrived on the station in May, 1906, to relieve the "Sentinel," and has not contributed any cases.

H.M.S. "*Surprise.*"—This is the Commander-in-Chief's yacht and has been out on the station for many years. She has a complement of 107 men and was last recommissioned on February 21, 1905.

Movements.—She was in dock or alongside from December 5, 1905, to January 19, 1906, but since that time has only been in Malta for very short periods, except from May 25 to June 14. Her next visit was from August 2 to 5. Owing to her small size she is moored close to the shore and her officers state that mosquitoes are nearly always troublesome on board. Her usual billet this year has been in Dockyard Creek close alongside Senglea, so that she is really in closer relation to the houses in that place than are ships in dock on the other side.

Up to August 23 no case had occurred in the ship, although two of her men during the time she was in dock contracted the disease while in Bighi for other illness. On August 23 her engineer officer was taken ill, and on November 3 one of her lieutenants was sent to the "Maine" hospital ship. The latter officer, however, had been ill for some time and the onsest of his illness is returned from Haslar as July 21. No other cases have occurred, and although this is rather suggestive of a contact infection it is curious that officers should as usual be singled out for attack, since the nearness of the shore to the anchoring billet occupied by this ship when in Malta affects officers and men alike.

H.M.S. "*Vulcan*" *and the Destroyers.*—The "Vulcan" is now the parent ship of destroyers and has a complement of about 448 men; the crews of the destroyers bring the total to about 1180. She has been 12 years on the station, but was recommissioned in March, 1905. Her sick bay accommodation has not only to be used for her own men, but also for the crews of her satellite destroyers and in consequence is entirely inadequate, so that an extra sick bay has constantly to be screened off on the main deck and any severe case is as soon as possible transferred to hospital. Her latrines are also entirely peculiar to herself, as they are on the main deck and not the upper deck, but are approached from the latter by a narrow and tortuous ladder, and, being also much sub-divided by partitions, are exceedingly badly ventilated, almost impossible to keep clean and dry, and

abominably malodorous. One would expect that if inoculation from infective excreta plays much part in the production of the disease among the barefooted seamen that it would find its best opportunity in this ship. The galleys too are close to the sick bay.

Milk Supply.—Fresh milk is supplied both for officers and sick bay.

Disinfection.—This is not a routine measure in case of Mediterranean Fever.

With the exception of the period between January 18 and 26, when she made a cruise to Gibraltar and back, this ship did not leave her moorings in Lazzaretto Creek until February 14. In this billet, where she lies surrounded by the destroyers, she is not very far from the beach, which is on the Lazzaretto side, a favourite breeding place for *Acartomyia Zammittii.* On February 14 she went round to Grand Harbour, and on March 7 went into No. 4 Dock for five days. On April 6 she left for Corfu, but returned again on the 18th to the Lazzaretto Creek, where she remained until May 5. She then took part in the Phalerum Bay demonstration, once more returning on May 21 and sailing again on June 5 with the fleet. She subsequently made a stay at Malta from August 25 to September 6 and returned for the winter on the 30th. She was therefore in Malta for the greater part of the first half of the year, and has been longer there than any other big ship.

During the first four months of this year there was a constant succession of cases, no less than 14 occurring, but since April 22 no single case has occurred among persons actually belonging to the ship herself. In the first of these cases the onset was December 24, the next January 18, then there was one on February 8, two on the 17th, another two days later, and two more on February 20. The next man had his first symptoms of Mediterranean Fever on March 12, but this was contracted while in hospital, so that no cases really occurred in the ship in March, and the onset of the next was April 1, when two first felt ill. Two more had their first symptoms on April 10 and the last on the 22nd. It has already been stated that one of these 14 actually contracted the disease while in hospital, but even more interesting is the fact that every one of the others without exception had been in hospital for other diseases within the three months preceding onset, the interval being under a month in five cases, under two months in five, and under three months in the remaining three, while the diseases from which they suffered were either venereal or surgical in 11 out of the 13. It is a very suggestive fact that a ship which is constantly obliged to send patients to hospital and also frequently contributes cases of Mediterranean Fever should have had an unusually large number in the early part of the year, all of whom had been in hospital, and that since the certain sterilisation of hospital milk, should have totally ceased to contribute cases, notwithstanding a fairly lengthy

stay in Malta. It points strongly not only to the hospital as the place of contraction, but to the milk as the vehicle of infection.

That being so it is interesting to find that in this ship also there is quite a marked grouping among the cases. Thus Mess 17 shows two, and Mess 15 another, while three belonged to Mess 23, and two more who fell sick on the same day to Mess 25. The sleeping billets of all in whom information was obtainable were widely separated.

Destroyers.—It is quite impossible to enter in any detail into the movements of destroyers except to say that as a rule the majority accompany the parent ship and that they are moored in Sliema Harbour close to her. A proportion of them are almost constantly in dock, under which circumstances a nucleus crew only is left on board and the remainder hulked in the "Cruiser" or turned over to another destroyer. Owing to the paucity of accommodation for the sick in the "Vulcan" they are usually sent to hospital when ill.

Twenty cases have occurred among their crews during 1906, and of these four first felt ill in January, two in February, four in March, four in April, three in May, one in June, and one in August. The last case had been notified as giving a positive reaction in his ship during pyrexia of about a week's duration in July, 1905, so that this was possibly a relapse. With four exceptions, including the case just mentioned, all had recently been in Bighi with other illness, but in two instances at a period more remote than three months. Of the remaining three who had not been in hospital, two were officers, and one of these was the June case and came from a destroyer which was alongside at the time. Just as with the "Vulcan," therefore, the occurrence of cases has greatly diminished coincidently with the certainty of sterilisation of milk in hospital.

Two ships provided three cases each, and three two cases each, but these showed no evidence of any connection, and some of them were almost certainly contracted in hospital.

Conclusions.—The period under consideration is too short, and the cases too few, to justify any definite conclusions, but so far as it goes it may be held to suggest:

(1) That defects in accommodation and ventilation and the prevalence of ailments resulting from these do not appear to exercise much influence.

(2) That duration of stay on the station appears to be of more importance, but that there are constant exceptions. Judging from the histories of the "Implacable" and "Irresistible," where a ship begins badly she tends to go on in the same way, and the converse is illustrated by the "Formidable."

(3) With very few exceptions, cases go on the list within six weeks of leaving Malta, and ships which are much away do not provide cases until after their return as a rule.

(4) Just as was found by Colonel Davies, there seems to be no relation between the completeness of the disinfection carried out and the occurrence of cases.

(5) The grouping shown would be more suggestive of mosquito or contact infection if so many did not show a previous hospital history and if it related to sleeping billets as well as to messes.

II.—Facts Elicited by the Study of Individual Cases.

In addition to the information derived from cases personally investigated, a considerable amount was available from forms which had been distributed in the fleet in 1905, and sent to my predecessor, or Staff-Surgeon Shaw, on the occurrence of a suspected or developed case of Mediterranean Fever.

Chiefly owing to differences in the speediness of diagnosis, these vary considerably in the completeness of the information recorded, and, accordingly, to almost every question there has been a differing number of answers.

The evidence in this part of the report is therefore derived from three sources—first, cases personally interviewed, 70 in number, including 48 from the Service afloat, 9 from the hospital, 8 from the dockyard, and 5 Maltese; secondly, a certain amount of information collected about 13 cases not personally interviewed, which occurred in ships away from Malta and never returned there; and, third, the information obtained from the forms referred to above. Where there can be no doubt as to the accuracy and completeness of the evidence provided, these will be combined, but otherwise they will be treated separately.

It is almost unnecessary to say that this part of the enquiry has been much interfered with by the continued absence of the fleet from Malta, and by the very gratifying decrease which has latterly taken place in the number of cases.

For obvious reasons connected with the difference of environment, these cases are considered under the following headings:—

Service afloat, officers and men; English civilians employed in the dockyard; Maltese, afloat and ashore; hospital residents. The facts with regard to these which have a bearing on hospital conditions have already been discussed at p. 74. For certain general considerations no such distinction is necessary, and these are therefore first dealt with.

Time on Station.—The shortest interval intervening between arrival in Malta and onset of symptoms recorded in these returns was 17 days. One case was probably only eight days, but no definite information is available. As will be seen from the next table, which, in addition to giving the duration of residence in the total number about which information was available on this point, also compares the interval

in those arriving in the hot and cold weather respectively, such a short period is decidedly the exception:—

Table XXVI.

Time in months on station......	Under 3.	3 to 6.	6 to 12.	12 to 24.	Over 24.
Those persons arriving from April to September	6	12	24	36	12
Those persons arriving from October to March	2	12	25	33	12
Total	8	24	49	69	24

Except for the period under three months, there is no evidence here that persons who arrive in the hot weather are attacked any earlier than those arriving in the winter, a fact which, in view of the way in which new arrivals suffer from the attacks of mosquitoes, rather argues against a mosquito-borne infection. It must be noted, however, that ships are more often absent from Malta in the summer than the winter.

Previous Service on Station.—Only 12 out of 52 persons who gave information on this point had previously served on the station.

In Dock or alongside Dockyard.—Twenty out of 99 cases developed in ships which had been in dock or alongside the dockyard wall within the previous 30 days, but one of these 20 was sleeping in the "Egmont." As the whole question of docking is discussed at p. 63, no further remark will be made, except to note that 10 of these had recently been in hospital.

The Presence of Sore Throat and other conditions of the Mouth which might conceivably provide opportunities for Inoculation by Micrococcus melitensis.—Only 14 out of 52 cases in which the presence or absence of sore throat was enquired into admitted having any throat symptoms, and similarly of 56 cases in which the condition of the tonsils was examined to ascertain the presence of chronic enlargement only 14 were found to be affected. The teeth were fairly good in 34, poor in six, and very bad in five. In answer to enquiries about smoking, all except five were found to smoke to a greater or less extent. The amount of evidence therefore suggesting possibilities of absorption from the mouth was not very great.

Infection from Abrasions produced on Urine-polluted Ground while playing games.—Although there does not seem to be a great probability of the recreation grounds in general use being much polluted in this way, the suggestion has been made that infection may thus occur, and the patients were therefore asked whether they had recently played in

Malta any games in which abrasions might be produced. Five out of 7 officers, but only 11 out of 44 men were found to have done so, and the probabilities are against this playing any part in the dissemination of the disease.

Facts elicited with regard to cases occurring in the Service Afloat.—In dealing with the incidence of the disease among this section of the naval population, one of the most important questions to determine is that of the possibility of the contraction of infection on board the ship itself and the various ways, if any, in which this may take place. Where a ship is lying in the stream, the methods by which persons on board are likely to be infected may for practical purposes be summarised as:—

(1) Infection by foodstuffs brought on board, and especially milk or its products.

(2) Various forms of contact, direct or indirect, with pre-existing cases, ambulatory or developed, occurring on board, and through the medium of biting flies with cases occurring ashore.

(3) Infective dust.

(4) Milk.

As milk containing *Micrococcus melitensis* is known to be supplied at times to ships, it seems by far the most probable vehicle of infection, which may occur as the result of ingestion, convection by flies to other food, or, possibly, in rare cases, by inoculation. The latter probability is not a great one as far as ships are concerned, since all officers' cooks are Maltese.

With regard to the ingestion of milk in Malta, notes were obtained of 59 men belonging to the Service afloat, excluding cases among Maltese. Thirty-five of these, including six of the Sick Berth Staff at Bighi, already dealt with at p. 56, had had milk while in hospital, and one other, at least, while on the sick list. Two more had taken it in some form elsewhere, and two had taken it, but not for a long time, one of these latter being an E.R. artificer from the "Vulcan," who was reported in July, 1905, to have given a positive reaction on board during a week's pyrexia. At that time he had been drinking milk daily in his home at Sliema, but had taken none since. Seven more men, including two of the Sick Berth Staff at Bighi, only admitted to having milk with tea, and two others, not personally interviewed, were said to have probably had milk. No notes were obtained about three cases, and seven denied having ever taken milk. As, however, of these latter, two were found to have been in Bighi recently, one for rheumatism, the other as a member of the staff, there is some reason for doubting the accuracy of this statement, which was not obtained personally. Out of 59 men, therefore, seven had milk only in tea, 42 in various other forms, and seven had none. On the other hand, of

11 officers, one had taken milk in hospital within a month of his illness, four more had had it elsewhere in various forms, and one was stated to have probably taken it. Three said they only took it in tea, but two of these had also had ice creams recently. About the two remaining cases, no facts were forthcoming on this point. Of the four who had certainly taken milk, one stated that he practically lived on it, but that it was always boiled by his Maltese servant in his house ashore, an assertion that there was unfortunately no opportunity of testing, and a second had, some three months before coming on the sick list, been trying a diet consisting of hot and cold milk alternately to the extent of about six pints a day. In no case among the officers, therefore, was there any absolute denial of milk drinking.

In the returns sent in to Staff-Surgeon Shaw the question asked was whether fresh goats' milk had been taken during the preceding 30 days. The following figures were obtained from the tabulation of these returns, cases contracted while in hospital, the Sick Berth Staff, and Maltese being omitted from the consideration :—

Among 40 patients who had recently been resident in Bighi for other illness, 38 had either had no milk since discharge, or where the interval before onset was over 30 days, for that period. Two gave a history of milk drinking, but one only in tea. The question of milk in hospital was in the majority of cases ignored, but has already been dealt with at p. 71.

Of 34 patients who gave no history of previous hospital residence seven, including three officers, had taken milk, but one only in tea, and a second had obtained the milk at Corfu.

Convection by Flies.—Since galleys and latrines are places where flies habitually congregate, and since infective material in the shape of milk is sometimes present in officers' galleys, and in the shape of urine in the latrines, especially that in the sick bay, a suggestion of the possibility of the conveyance of infective material in this way to food in messes near these special parts of the ship is not altogether unreasonable.

The relation of the affected messes to them has therefore been noted. In seven cases the mess was close to the officers' galley, and in four more to the ship's galley, three of the latter occurring in one group in the "Bulwark," as stated on p. 79. The group of cases in the "Irresistible," described at p. 84, belonged to messes not far from the sick bay and close also to the ship's head. The sick bay attendant in this ship and the sick bay steward in the "Implacable," both of whom messed and slept in the sick bay, also contracted the disease, but in their case the possibilities are, of course, more various. Out of the total of 70, therefore, 18 were in relation to these parts of the ship.

Other Forms of Food.—The sources of food, both that supplied by the

Service and by the canteen and messes, were investigated, but the only form, other than milk or its products, upon which suspicion can rest is to be found in raw fruits and vegetables. Of the 57 persons interviewed, however, seven stated that they never took either fresh vegetables or fruit, and in the majority of cases who were in the habit of taking the latter, skinned fruits, such as oranges, were the usual form.

Goat Cheese.—Only in the case of one man could a history be obtained of the ingestion of goat cheese, and it was not made use of in any ship in which enquiry was made. It may be regarded, therefore, as quite an exceptional article of diet. Butter is practically always tinned.

The Question of Hawkers.—The selling of food stuffs or drinks on board was only permitted in two sea-going ships, and neither of these had many cases of Mediterranean Fever. Milk was sold by hawkers in the "Egmont." As it was found, however, that ice creams were being sold to the men in one ship at least, a recommendation was made with regard to this, with the result stated at p. 73.

Mosquitoes.—With a ship lying out in the stream, biting flies might presumably be infected ashore, and either fly off where the ship was near the beach or be conveyed in boats with fruit or something similar. On the other hand, the possibility of their carrying infection from case to case on board must be admitted, but with prevailing conditions on a lower deck crowded with disturbing elements and subject to repeated cleansing a long stay by a mosquito in any particular part is decidedly improbable. As, however, such a method of dissemination has been suggested, it was desirable to note relationships to pre-existing cases and to possible reservoirs of infection in the shape of Maltese on board.

The grouping in three ships, which has already been discussed, refers to messes during the day, and not to sleeping billets, which in the majority were far apart. Since during the day the bluejacket is pretty constantly occupied away from his mess, such a grouping is, therefore, far more suggestive of something connected with food supply than of mosquito infection.

Out of the 70 cases 12, including two belonging to the Sick Bay Staff of ships, were found to have been in the near neighbourhood of pre-existing cases, usually in the same or adjoining mess. Eight more, while recently in hospital for other illness, had been in the same ward and in neighbouring beds to cases developing there. In the old returns contact was noted only in five cases out of 60, four of these referring to contact while in hospital. Of the personally investigated cases five more had been in near relation to Maltese on board who may have been suffering from ambulatory attacks. Two are especially suggestive, the first having two Maltese sleeping on the deck below

his hammock, and also having worked just before his illness with the dockyardsmen carried by the ship, of whom two were found to react, while the second was working on board his destroyer with several dockyard men.

With regard to direct evidence about mosquito bites, seven persons said that they were very rarely bitten, 18 occasionally, 10 frequently. Three more did not remember being bitten, but their messmates had recently complained, and 19 had neither been bitten nor heard complaints. A good many of the persons who admitted to having been attacked stated that they had been much bitten on first arrival on the station, but not so much latterly.

Taking all this evidence for what it is worth it cannot be regarded as pointing very strongly to direct contact infection or as greatly incriminating mosquitoes.

Indirect Contact.—Infected clothing or bedding. Only one man out of over 150 who were asked the question was found to have ever used any but his own hammock, and even in this case it is quite improbable that this had been used by a pre-existing case. This possibility may, therefore, be disregarded. With the exception of the Sick Berth Staff, too, practically no histories were obtained of contact with the effects of patients suffering from the disease. A very few had taken part in transferring patients to the Mediterranean Block while in hospital, or in taking bedding to the disinfector, one or two had collected the clothing of messmates on board, but the number of histories of the sort is so insignificant that it is hardly worth recording, and the amount of risk run in such cases was practically nil as compared with those constantly incurred by the Sick Berth Staff in hospital.

Inoculation from Infective Excreta in Double Bottoms and other Parts of the Ship.—The habits of the Maltese labourers working on board have already been referred to at p. 65, and this affords, therefore, quite a reasonable possibility. Information on this point was obtained in 169 cases, of whom nine had, just previous to the onset of illness, been working in bilges, seven in double bottoms, while 153 had not been engaged in any work of the sort.

Inoculation from Infective Urine on the Floor of Ship's Heads or the Dockyard Latrines.—In only one case of the 169 was the person attacked working in heads or latrines, so that the evidence is against this method of transmission. A very similar possibility, however, exists in the practice of going to the ship's head barefoot, especially in view of the prevalence of sea cuts and other aids to inoculation. The very general distribution of cases and the special liability of officers argues against this playing a very important part, but the question was asked in 24 cases, 12 of whom stated that they always wore some form of foot covering, five occasionally went to the head without and seven frequently did so.

Examination of Contacts, Previous Cases, and the Maltese in Ships.—In a ship, as opposed to a house or barrack room, it was obviously waste of time to attempt to examine contacts, and this has accordingly only been done in a few cases occurring ashore. The 13 men composing the hospital guard were examined on the occurrence of a case among them, and the husband and daughter of Mrs. T. (see p. 106), who had been ill some six weeks before she was, were also examined, but in every case the reaction was negative.

The Maltese on Board Ship.—It had been intended to examine for the presence or absence of agglutination reaction all the permanent Maltese in the fleet, and to plate out the urine of those who gave a good reaction. This project was, however, greatly interfered with by the continual absences of the fleet, and in the second place, owing to the constant pressure of other work in the laboratory, one did not feel justified in asking for much work of this sort to be done. Surgeon Hunt of the "Suffolk" very kindly examined the men in his ship, while away on a cruise, and sent those reacting to the laboratory for verification.

The following table represents the results so far as the examination extended:—

Table XXVII.

Ship.	Number of Maltese examined.	Number reacting.	Urine examined.	Number of cases of Mediterranean Fever in year.
"London"	28	1 up to $\frac{1}{50}$ +	—	13
"Implacable"	29	1 " $\frac{1}{20}$ +	—	14
"Diana"	13	1 " $\frac{1}{100}$ +	Once. Nil	4
"Minerva"	18	3 " $\frac{1}{30}$ + 2 " $\frac{1}{10}$ + 1 " $\frac{1}{10}$ ±	Twice. Nil	Nil
"Irresistible"	27	1 " $\frac{1}{10}$ +	—	14
"Suffolk"	20	2 " $\frac{1}{20}$ +	—	Nil this commission
Total	135	12	Nil	

The history of these cases was enquired into in several instances.

The one man in the "London" stated that he had never had any fever, while the one in the "Implacable" was 78 days under treatment in Bighi at the beginning of the year with Mediterranean Fever.

The cases in the "Minerva" were carefully enquired into by Surgeon Richardson, and of the three who gave a good reaction, one stated that he had never been ill; another, that he had only been laid up for about a fortnight three years previously with what was said to be a cold, while the third had had Mediterranean Fever five years before.

The urine was also plated out in three ambulatory cases, two in hospital, and one belonging to the "Diana," and in two previous cases occurring in the "Implacable," and one in the "Carnarvon," but no *Micrococcus melitensis* was ever isolated.

The blood of 48 out of the 53 dockyardsmen who at various times in the early part of the year were embarked in different ships for the purpose of fitting fire control were also examined. Two gave a + reaction in 1 in 10 and 1 in 20 dilution, two only in 1 in 10, and two more gave a doubtful reaction in 1 in 10.

This investigation, so far as it goes, would appear to indicate, that, as might be expected, latent infection exists among the Maltese in ships, but would not suggest that it plays any part in the dissemination of the disease. In the Table above it will be noted that the ships which suffered least had the largest proportion of Maltese giving a positive reaction.

Evidence with regard to the Possibilities of Exposure to Infection Ashore.—Men.—Of the 59 men whose cases were personally investigated, nine were living in Bighi Hospital, and 29 more had recently been there as patients, eight within a month, 11 within two months, and seven within three, the rest over that time. Since the discharge from hospital of these 29, 12 had been ashore in Malta once or twice, seven occasionally, two frequently, while seven had not left the ship. One more had not been ashore in Malta, but occasionally in other places. Similarly, 14 had occasionally (in the majority of instances once or twice) slept ashore since discharge from hospital, and 13 had not done so at all. No information on this point was available about two.

Of the 21 men who had not been resident in hospital, two were once or twice ashore in Malta in the six weeks or more preceding the onset of illness, eight occasionally, three frequently, and two were living ashore, but one of them for only about a week at the range. Three others were occasionally ashore elsewhere, but not at Malta, and three were never ashore at all. The figures with regard to sleeping very closely correspond to the others: seven slept ashore occasionally, three frequently, and 11 had not done so at all.

Officers.—Only one out of the 11 had been previously in hospital, and in the interval between discharge and onset he was living ashore. Of the remainder, one was ashore in Malta once or twice, two occasionally, three frequently, and the remainder, with the exception of one whose destroyer was alongside the dockyard, were living ashore. Only these latter, four in number, had slept ashore at all lately.

Table XXVIII.—Showing Movements of Patients, either for the Entire Interval since Discharge from Hospital or during the 30 Days preceding Onset.

—	Ashore in Malta.				Ashore elsewhere only.		Slept ashore.		
	Once or twice.	Occasionally.	Frequently.	Never.	Occasionally.	Frequently.	Occasionally.	Frequently.	Never.
In hospital.									
Movements known for entire period—									
Within 1 month	8	1	9	3	—	—	4	5	12†
„ 2 months	4	1	4	3*	—	—	3	1	8*
„ 3 „	2	—	—	—	—	—	2	—	—
Total	14	2	13	6	—	—	9	6	20
Movements only known for 30 days—									
Within 2 months	3	3	1	1	2	—	5	—	5
„ 3 „	4	2	—	2	1	—	4	—	5*
Over that time	1	1	—	—	—	—	2	—	—
Total	8	6	1	3	3	—	11	—	10
Not in hospital.									
Movements only known for 30 days—									
Officers	1	—	2	—	—	1	—	—	4
Men	6	8	9	7*	2	1	12	5	16‡
Grand total	29	16	25	16§	5	2	32	11	50‖

* 1 in dock. † 1 alongside. ‡ 3 in dock. § 2 in dock. ‖ 6 in dock or alongside.

The one officer in hospital previously had been once or twice ashore, but had not slept; his ship was, however, alongside.

The evidence derived from the forms sent in to Staff-Surgeon Shaw relates in the large majority of instances to the movements of patients in the 30 days preceding onset, since that is the form in which the question was put; but in a few, who had recently been in hospital, information is given with regard to the period since discharge. Omitting cases contracted while resident in hospital, and those occurring among the Sick Berth Staff there, and also the Maltese and dockyardsmen, information is available on this point in 93 cases, of whom one officer and 55 men had recently been in hospital, and in 35 of these their movements for the entire interval between discharge and onset are recorded. The results are perhaps best put in tabular form (see Table XXVIII, p. 101).

So far as it goes, therefore, this information—which may be accepted as pretty accurate, since in the large majority of cases it has been verified by examination of leave books—agrees essentially with what has already been stated. Officers, for instance, are seen to go ashore more than the men in the daytime, but, in the case of those serving afloat, to sleep ashore much less frequently. It follows, therefore, that this suggests some cause operating in the daytime to account for the increased liability among them.

It shows also that the majority of the cases developing after treatment in hospital for other illness have been comparatively little exposed to the chance of infection ashore, and that the possibilities of this having occurred during the interval after discharge from hospital are therefore correspondingly lessened.

Facts Pointing to the Contraction of the Disease in Malta rather than elsewhere.—Evidence with regard to the period intervening between departure from Malta and onset of symptoms has been collected in 60 cases which occurred during absence from Malta, and the following table gives the result:—

Table XXIX.—Showing Interval between Departure from Malta and Onset of Symptoms in Cases occurring elsewhere.

Within 1 week.	2 wks.	3 wks.	4 wks.	5 wks.	6 wks.	7 wks.	8 wks.	Over 8 wks.
15	11	11	8	5	4	1	2	3

The enormous majority are seen to occur within a month of departure, and further evidence is afforded by the diminution which inevitably follows the departure of the fleet during the summer, and which during the past two years has been accentuated by the increasing length and frequency of the cruises.

Dockyard. Civilian, English.—A group of cases of Mediterranean Fever occurring among dockyard officials and their families in Sliema.

Incidence of Cases.—The earliest case occurred in the person of Mr. J. J., draughtsman in the dockyard, who lived in a flat situated in one of three houses (House B) belonging to a boarding establishment in Sliema. He had only been in Malta three and a half months and first felt ill on April 12. Almost at the same time, about April 16, two out of four children in the family of another dockyard official, living some 400 yards or more further down the same street (House A), also complained of illness and one gave a positive reaction, the other being only ill for a week and her blood not being tested. On April 27 a third child in the same family became ill, and presented a positive reaction. The fourth and only other child was an infant 10 months old. On going into the history of this second family it was found that until two months previously they had lived in the same house as the first case and, in fact, had for some time been fellow lodgers, but had seen little of one another since leaving. This family had been two and a-half years in Malta and had always used milk unboiled, the children chiefly with porridge. The mother also used the milk, but previously they had none of them suffered from illness. The milk was obtained from the same goat-herd as in the house where the first case occurred. On May 11 Mr. E. H., living in the same boarding establishment as Mr. J. J., but in the third house (House D), that is to say, the house at the opposite end of the establishment of three, had a febrile attack and symptoms suggesting Mediterranean Fever, but gave no reaction. When seen on June 19, however, a tube of blood was obtained and when tested was found to react up to 1 in 200, although he had returned to duty on May 21 and was apparently well. On May 21 Mr. T. C., draughtsman, living in the same house, was attacked by pain in the foot and fever which lasted till the 28th, and on June 8 was placed on the list with what proved to be a severe attack of Mediterranean Fever.

All the houses are situated on the sea front and accordingly in close relation to the very numerous breeding places of Acartomyia which are to be found on the rocks at Sliema, while the street is also much exposed to wind, and consequently to dust. The houses are comparatively recently built and the sanitary arrangements were in all cases modern in design and in good order.

The boarding establishment in which Messrs. J. J., E. H., and T. C. lived consisted, as has been stated, of three houses (B, C, and D), two of which (C and D) were in communication and served as a sort of mess, while the other (B) was let in flats. This latter house had been given up at the time the second case occurred. They were administered and supervised by the same staff, and the milk supply was the same for all. None of the five Maltese servants gave any history of recent illness.

That part of the establishment used as a mess accommodated nine dockyard officers, four of whom lived in the middle house (House C) (none of whom were attacked), while five lived in the end house (D) and two of them suffered. Among them, Mr. T. C. had been the shortest time in Malta (nine months), while Mr. E. H. had been two years in the island. All except one had been in the habit of taking fresh goats' milk with porridge and also in tea; the one exception took it in tea only. He has not suffered from Mediterranean Fever. Mr. J. J., the first case, who had lived in the other house (B) in a flat with his wife, also took it with porridge.

All but two of the nine used mosquito nets, and all agreed in saying that mosquitoes had not been troublesome this year, but that last year they were a great nuisance in the dockyard. The two who used no curtains were neither of them attacked; one of them lived in the centre house of the three (C) where no case occurred, and the other in the same house (D) as the last two patients. Mr. J. J. also used a mosquito curtain and stated that he was extremely particular about it, examining it each night with a candle before retiring. Mr. T. C. appears to have been in the habit of doing much the same.

Previous Cases in House.—Two cases had occurred in August and September, 1905, both of whom lived in house (D). In addition, another of the mess had been attacked after arrival in England on leave about August, 1904, but at this time, although the establishment was the same, the house was an entirely different one and in a street further from the sea.

Milk Supply.—The same goat-herd had supplied the establishment for a long time and was in addition the usual source of supply for the family in which the three children were attacked, but in contra-distinction to the latter who drank the milk unsterilised the proprietress assured me that the milk was always scalded before use and was most emphatic in her expressions of confidence in the reliability of her Maltese servants on some doubt as to this being suggested. On the occurrence of the second case (Mr. T. C.), however, the house was again visited, and some milk standing by his bedside was tested and found to give the characteristic reaction with the ortol test. A further sample was then requested and was brought up by one of the servants who, on seeing the test about to be applied, volunteered the information that it had not yet been scalded. As the hour at which the milk was delivered was said to be 5.30 a.m., and it was then nearly noon, one may be pardoned for expressing doubts as to whether the confidence reposed in her domestics by the mistress of the house was not misplaced. A sample of this milk was sent to the laboratory, but was too contaminated for examination.

Samples were afterwards obtained from 20 of the animals belonging to this goat-herd and one was found on repeated examination to give a

very marked reaction and was frequently plated out in the Public Health Department, but *Micrococcus melitensis* was never isolated. This herd is dealt with in Dr. Critien's report, and on comparison with him it was found that he received notifications of three cases from a house (House E) in a street quite a quarter of a mile away, but supplied by the same milkman. The dates of onset in these three were April 20 and 24 and June 15 respectively.

Among the persons, therefore, supplied by this herd, which included at least one infected animal, no less than eight undoubted and one possible case of Mediterranean Fever occurred within a comparatively short space of time. These were located in four different houses, in three instances widely separated from one another, while no such correspondence was to be found between them in conditions suggesting other methods of infection.

The following table recapitulates the dates of onset:—

Table XXX.

Name.	Sex.	Date of onset.	House.	Remarks.
Mr. J. J.	M.	April 12	B	
C. J.	M.	„ 16	A	
C. J.	F.	„ 16	A	Only a week ill. No examination for reaction
Mr. S.	M.	„ 20	E	Dr. Critien's report
Mr. G.	M.	„ 24	E	„ „
F. J.	F.	„ 27	A	
Mr. E. H.	M.	May 11	D	Only a week ill, but reacted in dilutions up to 1 in 200
Mr. T. C.	M.	„ 21	D	
Mr. O'R.	M.	June 15	E	Dr. Critien's report

It may be mentioned that Messrs. J. J., E. H., and T. C. all worked in the dockyard, in the same block of buildings, and stated that last year they were much troubled there by the attacks of what was evidently from the description *Stegomyia fasciata*. All, however, agreed in stating that up to the time of illness this year none had been seen, which is quite in accordance with what might be anticipated at the time of year. At all events, the prevalence of mosquitoes in the dockyard would throw no light on the remaining cases and the probabilities would seem to be enormously in favour of milk as the vehicle of infection in this series of patients.

Isolated Cases among English Civilian Dockyard Employees.—In addition to the group of cases just discussed, three isolated cases were personally investigated.

Environmental Conditions.—One man, S. B., an engine fitter, lived in Vittoriosa; a second, E. W., and the third case, a female, Mrs. T.,

the wife of a dockyard employee, lived in different parts of Senglea. In all three cases the house was situated in dirty crowded localities, infested by goats and other animals, and in all three the sanitary arrangements were of the peculiar Maltese type described by Johnstone, and left much to be desired. By far the most objectionable in this respect was that of Mrs. T., where there was a hand-flushed closet pan in the small room where cooking was carried on, an open communication with the drain just outside the window, and another hand-flushed closet just outside her bedroom door. With regard to the sanitary condition of surroundings, therefore, these few cases are seen to afford a most notable contrast to the conditions under which most cases in the Service afloat are contracted.

Milk History.—S. B. had been in hospital in January, 1906, for some considerable time with rheumatic symptoms and a slight urethral discharge. On February 2nd, but never again, his blood had given a positive reaction in a dilution of 1 in 50. During this stay he had had milk, and he had also been in the habit of drinking it by itself in his own home; but in his present lodgings, which he had occupied since discharge from hospital, it was said to be tinned. The symptoms of his definite attack of Mediterranean Fever began early in June, but the probabilities are rather in favour of his first stay being also due to this cause.

In both the other cases a milk history was easily established, E. W. taking it in egg flips and Mrs. T. with fruit. In both cases the milk was obtained in the usual way from casual goat-herds at the door.

Contact.—In the case of the two men there had been no recent illness of any sort in the house, but the husband and one daughter of Mrs. T., both of whom had taken milk, had, some six weeks previously, suffered from pyrexia. In both, however, the agglutination reaction was negative.

Mosquitoes.—S. B. stated that these had troubled him in the house he had occupied before going to hospital the first time, but not in this one. E. W., whose symptoms were first noticed about the middle of September, had been much attacked in the boiler shop in the dockyard by a striped mosquito, evidently Stegomyia, and by a smaller variety in his house, but Mrs. T. had not noticed any. Neither of these three persons used nets, and the probabilities are that mosquitoes were numerous in all three houses.

Maltese.—The Maltese personally interviewed included four serving in ships, and one policeman in the dockyard. All, however, slept ashore while at Malta. Owing to linguistic and other difficulties, information had been hard to obtain in these cases and is not altogether reliable, more particularly with regard to previous history, contact with other cases, and facts relating to mosquitoes.

The details may be summarised as follows:—

All lived in entirely different parts of Malta, including Cospicua, Casal Paula, Zabbar, Misida, and Senglea, and all belonged to different ships. Three gave histories of similar illness previously, two nine years before, and the third in 1905, but neither had been in hospital. Four occurred while at Malta, the last a fortnight after leaving.

Contact and Mosquitoes.—No history of any contact with pre-existing cases could be obtained. One man said he was never troubled by mosquitoes, a second was occasionally bitten, a third that they were numerous in his house, but that he used a sheet as a protection. No information could be obtained from the other two on this point.

Milk History.—Two drank milk freely by itself, a third took it with porridge and fruit, and occasionally by itself on board his ship (he was a gunroom domestic), the fourth took it only in tea except when ill, and the remaining man denied taking it at all, but his knowledge of English was so limited that the information in this case is by no means reliable. Four cases were reported on the old forms, and of these two drank milk; about one man it is stated that he did not drink it on board, and as to the fourth there is no information whatever on this point.

The evidence to be derived from these few odd dockyard cases and Maltese is entirely inconclusive, but on the whole it is not incompatible with milk infection.

III. A MORE COMPLETE HISTORY OF THE OUTBREAK OF MEDITERRANEAN FEVER ON BOARD THE S.S. "JOSHUA NICHOLSON."

The original account of this outbreak of Mediterranean Fever on board the "Joshua Nicholson" was given in the correspondence column of the 'Journal of the Royal Army Medical Corps' for January, 1906, in the following letters from Dr. M. Armand Ruffer, Captain Kennedy, R.A.M.C., Malta, and Dr. Gotschlich, Director of Sanitary Services at Alexandria, respectively, and in an editorial in February, 1906 :—

DEAR BRUCE,—I have just seen Dr. Gotschlich, who told me of a ship starting from Malta with a number of milch goats for London. The captain, officers, and a certain number of the crew drank the milk, and nearly all those that did so contracted Malta Fever, whereas the others did not. I have urged Dr. Gotschlich to publish particulars at once.

Yours sincerely,
M. ARMAND RUFFER.

DEAR COLONEL BRUCE,—I came across a very interesting thing in connection with the infection of Mediterranean Fever by means of goats' milk. I got to hear from Dr. Stilon, who is writing for fuller

particulars, of a ship trading between Antwerp and Egypt, which called in here the other evening, and the captain of which and another man came ashore to consult Dr. Stilon, who found them suffering from symptoms of Mediterranean Fever. He took samples of their blood, which he sent to the laboratory. Dr. Micallef did the reactions, and I only saw them after he had put them up, when there was an undoubted reaction. He had no more blood for me to test.

These two men left Malta on board their ship early next morning, and I did not hear of the case for 24 hours after, but particulars of which, as far as I can gather from Dr. Stilon, are as follows:—

Two months ago the s.s. "Joshua Nicholson" called at Malta and shipped some goats for Antwerp. On the way the crew drank the goats' milk unboiled, with the exception of one man (a carpenter or engineer), who refused it. At Antwerp they left the goats and shipped on a new crew, with the exception of the captain, the mate, the above-mentioned carpenter or engineer, and two other men. After leaving Antwerp, one of these five men went sick, and had to be landed at Gibraltar; another was very ill at Alexandria, and his blood was sent ashore to be tested, and was said to react to *Micrococcus melitensis*. They proceeded to Odessa, where others fell sick, and by the time they had come back to Malta all of the five men were sick with the exception of the one man who refused to drink the goats' milk.

I have written to Horrocks, at Gibraltar, asking him to try to trace the man who landed there, and Dr. Stilon is writing to Antwerp to get more particulars, which I have asked him for. It is most unlikely that the infection was contracted in any other way, as they merely stayed here a few hours, and did not, I suppose, even land.

Yours sincerely,
(Signed) J. CRAWFORD KENNEDY.

Valletta, Malta,
December 14, 1905.

The Editor, 'ROYAL ARMY MEDICAL CORPS JOURNAL.'

DEAR SIR,—At your request I send a report of a small epidemic of Malta Fever, which occurred on board the s.s. "Joshua Nicholson" (Ellerman Line). On October 21 last, Frederick Jenkins, aged 33, steward of the s.s. "Joshua Nicholson," which was anchored in our port, was admitted into the Deaconesses' Hospital of our city with the clinical signs of Malta Fever. At the request of Dr. Morrison, physician of the said hospital, I made a bacteriological examination of the blood of this patient (Widal's reaction), with the following result:—Positive agglutination with the *Micrococcus melitensis* in a dilution of 1 in 1200; control with the *Bacillus typhosus abdominalis*, negative in a dilution of 1 in 50. The result of the bacteriological

examination thus corroborates the diagnosis of Malta Fever. The patient left hospital, cured, on the 4th instant.

Dr. Morrison had the kindness to draw my attention to the history of the case, which is very interesting from the point of view of the relation between the infection by the *Micrococcus melitensis* in man and in the goat. Based on these communications on the part of Dr. Morrison, and on the information which I have been able to collect from the patient himself, the history of infection in this case is as follows:—

The s.s. "Joshua Nicholson" had, on the occasion of its previous voyage, starting from Odessa, anchored about August 19 last for about one day in the port of Malta to take on board a flock of 65 goats, destined for the United States of North America. Seeing that the stay of the ship at Malta had only been of so short duration, and seeing that, as I am assured, no one left the ship to go on shore, it is extremely improbable that the cases of Mediterranean Fever, which appeared later amongst the crew of this vessel, could have been contracted during the stay at Malta by direct or indirect contagion. The ship then continued her course from Malta to Antwerp, where she arrived about September 5 last. During the whole voyage every one on board (to the total of 24) had drunk fresh milk from the goats embarked at Malta. These latter were transhipped two or three days after arrival at Antwerp to a ship leaving for a port in North America, of which, unfortunately, I have not been able to learn either the name or the exact locality.

The s.s. "Joshua Nicholson" remained at Antwerp for about two weeks, proceeding next to London. It was during the last days of the stay at Antwerp, or during the voyage to London (I have not been able to obtain exact information on the subject of these dates), that four people on board fell sick with fever, whilst during the whole of the voyage from Malta to Antwerp, and during the greater part of the stay in the latter port, every one had been in perfect health. The sick were: the captain (slightly attacked), the first officer, the chief engineer, and the steward. As to the last, I have been able to prove, since his arrival here, that he suffered from a typical attack of Malta Fever; as to the three others, it has been impossible for me to obtain a bacteriological examination of their blood, but I have been assured that their clinical symptoms were absolutely identical with those observed in the steward. In all probability Malta Fever was present in all four cases. In addition, there is a fifth case, a certain Swartier (?), treated in the Dreadnought Hospital at Greenwich, London, but I have not been able to learn what may have been the symptoms of his sickness. Perhaps it would be possible to obtain information with regard to him from the authorities of the above hospital. It would, indeed, be particularly interesting to know if

this individual also had Mediterranean Fever, for that would prove that the case existed, not exclusively in the officers' quarters (captain, first officer, and where the steward principally carried out his duties), but also among the crew.

To sum up, we find ourselves in the presence of a small epidemic of Mediterranean Fever on board a ship which had embarked a flock of goats at Malta, and among persons who had drunk unboiled milk from these goats. Now, as according to the researches of the Commission of the Royal Society for the investigation of Malta Fever, the goats of Malta are very frequently infected by this malady, and as it is proved directly that the *Micrococcus melitensis* is secreted often in enormous quantities in the milk of these goats, there would be nothing surprising in finding that people who had drunk such milk had contracted this infection; besides, this will be the first time that this mode of infection in man by the milk of the goat will be directly demonstrated. The hypothesis would have more in support if one could prove that the above-mentioned Swartier, one of the crew, had likewise been attacked by Malta Fever. But if that is not the case, we ought not to disguise from ourselves that there may be yet another possible way of explaining the infection in this little epidemic—it is, that all the four people attacked were in the officers' quarters, and were there daily in contact with a passenger, an American, who had been several months in Malta buying the flocks of goats, and who accompanied the latter to their destination. Unfortunately, I have not been able to get the name of this gentleman. As to his state of health, the steward assured me that he was apparently always very well—nevertheless, this does not exclude the possibility that this gentleman may have contracted Mediterranean Fever during his long stay in Malta, and that he may have retained and propagated the infection in the latent stage, *e.g.*, by the urine, following the analogy of certain convalescents from typhoid fever who, while being apparently in perfect health, can for several months propagate the infection. Perhaps it may be possible to clear up this question by later investigations on the subject of this passenger.

As regards the goats, which, according to what I have heard were destined for establishments for supplying milk to children in America, I have drawn the attention of the Consul of the United States in our city to the danger likely to ensue under this head.

Up to the present I have not been able to get further information as to what has become of these goats.

Pray accept, Mr. Editor, the assurance of my esteem.

(Signed) E. GOTSCHLICH,
Director of Municipal Sanitary Services of Alexandria.

Alexandria,
December 8, 1905.

More recent investigation has elicited additional facts in connection with the causation of this outbreak, and has also shown that some of the details as originally stated were not quite in accordance with the actual circumstances. I propose, therefore, to recapitulate the facts from the beginning.

Much of the additional information has been obtained directly from the chief of the three goat-herds who accompanied the animals to America, and from the captain, chief engineer, and steward of the "Joshua Nicholson," who still belong to the ship.

The History of the Goats.—The entire herd numbered 65, of which 61 were milch goats. These had been gradually collected in Malta by Mr. Thompson, of the Bureau of Animal Industry, U.S.A., who had been living in the Island for some months for the purpose.

These goats were embarked for Antwerp, en route to America, in the s.s. "Joshua Nicholson," which called at Malta on August 19, 1905, for a few hours. Mr. Thompson and three Maltese goat-herds accompanied them. The animals were placed in pens on deck in the waist, over the after hold, where they must have been somewhat crowded together from the restricted space available. One milch goat, a prize animal—and the finest of the herd—died the day after sailing, and was examined *post-mortem* by Mr. Thompson, who decided that pneumonia was the cause of death.

Except on one occasion the weather during the voyage is said to have been good, but as the two assistant goat-herds were seasick most of the trip, the goats may possibly have also suffered. At all events, there is a discrepancy between the accounts of the chief goat-herd and the people in the ship: the former declaring that all the animals were in good health and milking during the entire journey to America, and that the total output was about 120 quarts (30 gallons), but the latter insist that the supply of milk greatly diminished towards the end of the voyage to Antwerp and that the chief goat-herd was much concerned and spoke to Mr. Thompson on the subject. This information I obtained independently from two persons who entirely agreed in their evidence and am therefore inclined to believe that the goat-herd's memory fails him in this respect; more particularly as on again questioning him with reference to this point he admitted that three or four goats did fail to secrete milk when the ship was nearing Antwerp.

Most of the ship's company drank freely of the milk during the trip. For those living aft it was collected in a large salad bowl or soup tureen which held the milk of three or four goats, but from the steward's account, the majority of the men used their own pannikins and in consequence often drank the undiluted milk of a single animal.

The ship arrived at Antwerp on September 2, and the goats were at once landed and sent to the quarantine station. Here they remained

five days, during which time, by Mr. Thompson's order, the goat-herd gave milk from the goats to several persons in and around the station.

On September 7 the herd was embarked in the s.s. "St. Andrew" for passage to New York, Mr. Thompson and the three goat-herds once more accompanying them. The goats were accommodated in this vessel down below in the hold, and not on deck. The weather according to the goat-herd was bad throughout the trip: he further states that the 61 goats were still all milking, but as one of them was dead, a fact he had evidently forgotten, his evidence cannot be accepted as entirely trustworthy on this particular point. The captain of the "St. Andrew," however, corroborates him to some extent, and says that the total output of milk was about 160 quarts (40 gallons).

With regard to the collection of milk, one utensil appears to have been used for the officers and one for the crew, but some of the latter at times drank the undiluted milk of a single goat. Most of the ship's company seem to have drunk the milk.

The ship arrived at New York about September 21 to 23, and the animals were at once taken to the quarantine station in Athenia, N.J., and have been kept in quarantine ever since. Very shortly after their arrival, in the early part of October, the urine, blood, and milk of 60 (the remaining five having died) were examined. The blood of 14 showed a well marked agglutination reaction with *Micrococcus melitensis*, 18 more showed an imperfect reaction and 28 gave none. A Micrococcus corresponding in morphology and cultural characteristics to the *Micrococcus melitensis* was isolated from the milk of two of the goats on November 27 and subsequently from that of several more. All the goats have been kept constantly in quarantine and the infected ones have been killed off from time to time. At present 35 of the original goats and 40 kids of various ages remain in quarantine at the Government Experiment Station at Bethesda, Md.

The Incidence of Mediterranean Fever Among those who Partook of the Milk.

In the s.s. "Joshua Nicholson."—In this ship there were 23 officers and men during the voyage from Malta to Antwerp. Eleven of them left the ship at the same time as the goats and the after history of eight of these is unknown, but the remaining three are said by the captain to have been later under treatment in hospital at Antwerp with very similar symptoms to those from which he and the other men suffered. Their names and ratings are:—J. Johansen, carpenter; E. Olsen, boatswain; and De Halle, mess-room steward. The only one of these men, however, about whom any information is to be obtained in Antwerp is Olsen, who was in hospital there, but the only medical history is one of hernia.

Twelve of the original crew were left on board and the following

table gives (1) the names and ratings, (2) whether or not they suffered from illness, (3) whether such illness was verified by the agglutination reaction, and (4) the date of such verification. A more detailed account of the after history of each person is given subsequently.

Table.—Cases of Malta Fever in the Crew of the "Joshua Nicholson."

Name.	Rank or rating.	Whether sick or not.	Whether verified by agglutination.	Place and date.
A. Cherry ...	Master	Yes	Yes	Malta 4/12/05
F. Simonds	1st mate	"	"	" 4/12/05
D. Smart ...	Ch. eng.	"	Reacted July/06	" 25/7/06
Unknown ...	2nd mate	No	No	
F. Jenkins	Steward	Yes	Yes	Alexandria 21/10/05
A. Visschers	Cook	Yes (still sick)	Not known	
P. Swaters	A.B.	Yes	Yes	Greenwich December/05
Johansen ...	A.B.	Yes (ambulatory)	No	
E. Martin...	Donkeyman	Yes	"	
Spurgeon ...	Engineer	No	"	
Mieback ...	"	"	"	
Jenkins ...	Cabin boy	"	"	

The next table gives the movements of the ship during the voyage under consideration and for the following few months, which will help to make clear the history of these cases.

Table.—Movements of the "Joshua Nicholson."

From—	Date of departure.	To—	Date of arrival.
Malta	August 19/05	Antwerp	September 2/05
Antwerp	September 20/05	London	" 22/05
London	October 1/05	Gibraltar	October 9/05
Gibraltar	" 9/05	Malta	" 15/05
Malta	" 18/05	Alexandria	" 21/05
Alexandria	" 27/05	Odessa	November 3/05
Odessa	November 28/05	Constantinople...	" 30/05
Constantinople...	" 30/05	Malta	December 4/05
Malta	December 4/05	Antwerp	" 17/05
Antwerp	January 1/06	London	January 2/06
London	" 8/06	Gibraltar	" 15/06
Gibraltar	" 16/06	Malta	" 21/06

Of the 12 persons left in the ship four did not develop any symptoms of illness, and will, therefore, be dealt with first. They were the second mate, the cabin boy and the two engineers.

The second mate began drinking the milk, but found that it produced constipation and otherwise disagreed with him, and he therefore ceased taking it after having had but very little. He left the ship in

London some time between September 22 and October 1, apparently perfectly well, and cannot now be traced.

The cabin boy on this trip was the brother of the steward (who is now again in the ship) and has therefore been under observation up to the rresent time. The steward states that the milk disagreed with the cabin boy also, that he drank hardly any, and that he has had no illness.

The two engineers remained in the ship for the next voyage, but never had any sickness. They both drank milk, but told the steward that they always boiled it, to which he replied that he did not do so, as neither Mr. Thompson nor the captain thought it necessary.

The remaining eight persons all developed illness with very similar symptoms and five at least have given a positive agglutination reaction with *Micrococcus melitensis*, in dilution sufficiently high to eliminate the possibility of the reaction being due to other than specific agglutinins. In no case could a history of a previous attack of Malta Fever be obtained.

To take these eight persons seriatim:—

(1) *The captain*, who drank a great deal of the milk, states that he, together with the remaining seven (although the chief engineer and steward do not acquiesce in this latter assertion), first began to ail about August 31 or September 1, just a day or two before arrival at Antwerp. He was not, however, sufficiently ill to prevent him from doing duty or to necessitate his consulting a doctor until arrival in Constantinople on November 30, although he was noticed by the chief engineer and steward to be seedy while at Antwerp, and, moreover, was treating himself together with a number of the crew while on passage from London to Gibraltar and Malta. On November 30 he was so ill that he had to consult a doctor ashore at Constantinople, and on December 4 he came under the care of Dr. Stilon at Malta who had his blood and that of the first mate examined in the Public Health Laboratory, where they were both found to react to *Micrococcus melitensis*. The captain apparently improved somewhat after this, but on the next voyage out, about January 14, was exceedingly ill, and was seen by a doctor ashore at Gibraltar and again by Dr. Stilon at Malta on arrival there on January 21. On returning to England from this voyage he was under the care of Sir A. E. Wright and is now well, although his blood serum (July, 1906) still reacts in all dilutions up to 1 in 500.

(2) *The first mate*, like the captain, also drank the milk freely. He appears to have been able to carry on his work, and did not see a doctor until arrival at Malta on December 4, as already described. Subsequently, on the voyage from Malta to Antwerp, he began to have "rheumatic" pains, and, after sustaining an injury, some of his joints became swollen. On arrival in London on January 2, he left

the ship still unwell, and was under treatment by his own doctor at East Ham.

(3) *The chief engineer* usually drank the milk diluted with water. He was feeling quite well, he says, on arrival in Antwerp, and continued in good health until he got wet through the day before sailing for London, that is, September 19. This resulted in what he describes as a succession of colds which he could not shake off and for which he was under treatment by his own doctor at Forest Gate from September 22 to October 1, when he rejoined the ship. After leaving London he began to have various pains about the body and had an attack of fever, temperature 102° or 103° F., for which he was treated by the captain. He had pretty well recovered by the time the ship was between Malta and Alexandria (about October 20), and has had no return of illness, but his blood on July 25, 1906, reacted up to 1 in 80.

(4) *The steward*, who says he drank a very great deal of the milk, gives the same date for the commencement of his illness as the chief engineer, as he independently stated that he was wet through the day before leaving Antwerp (September 19) and had as a result severe shivering fits and could not get warm. This was followed by profuse sweats. He says that he was feeling particularly well on arrival in Antwerp, and, in fact, commented on it in writing to his wife. He managed to carry on his work until arrival at Alexandria on October 21, when he was so ill that he had to be sent ashore to the Deaconess Hospital. Here his illness was diagnosed as Mediterranean Fever and the diagnosis verified by the agglutination reaction (1 in 200). He was in hospital till December and then went home by mail steamer and rejoined his ship in London. His blood still reacted in dilutions up to 1 in 50 in July, 1906.

(5) *The cook* also drank the milk and was feeling ill during the voyage from London, but was able to continue his work until arrival at Antwerp again on December 17, when, being crippled by "rheumatism," he was obliged to leave the ship. He attended as an out-patient at a hospital there for some time, but got little benefit, and when the ship was at Antwerp about May or June, 1906, came on board for two or three weeks to try to do duty, but was obliged to give up. As far as is known his blood has not been tested.

(6) *Swaters, A. B.*—The history of this case is given in an editorial in the 'Journal of the Royal Army Medical Corps' for February, 1906. He appears to have drunk the milk like the others, and gives the date of onset of his illness as September 22, when symptoms came on suddenly. He was sent to the Dreadnought Hospital on September 29. Here a diagnosis was at first made of enteric as he gave a positive Widal reaction, but in December he reacted to *Micrococcus melitensis*, and had a typical attack of Mediterranean Fever.

(7) *Johansen, A. B.*—This man also drank the milk. He remained in the ship for the voyage to Malta, Alexandria, and Odessa, but was complaining of illness all the time, and left the ship at Antwerp on arrival in December. As far as is known, there is no record of blood examination.

(8) *Martin, Donkeyman.*—This man also drank the milk, but, as far as is known, his blood was not examined, and he has left the ship and cannot be traced. This was a mild case, and in date of onset, nature of symptoms, and duration practically corresponded to that of the chief engineer who appears, when in London, to have given him some of his own medicine.

Mr. Thompson, the passenger, is dealt with under heading "In America" (see below), and details relating to the three Maltese goat-herds are given on p. 117.

I am informed that for the five days at Antwerp the goats were in quarantine the milk was consumed both raw and boiled by the *personnel* of the station, and by many people in the neighbourhood with, so far as can be ascertained, no ill effect in any case. These persons, it is said, were enthusiastic about the quality of the milk.

The goats were visited on arrival and departure by the sanitary authorities, and were said to be perfectly well.

In the s.s. "St. Andrew."—The crew of the "St. Andrew" numbered about 30, most of whom took the milk, and there were on board in addition 30 cattle-men returning to the United States who also drank it, but up to the present it has been impossible to trace these men. It is obvious, therefore, that there were a great many more people *drinking* the milk than in the "Joshua Nicholson"—some 60 individuals instead of 23. Both the owners and the master of this ship, the latter of whom says that he has had the majority of the ship's company under observation up to the date of his letter (June 11, 1906), concur in stating that none of the men have suffered from any illness.

In America.—The Chief of the Bureau of Animal Industry states that since the arrival of the goats in America, although a number of persons have drunk each as much as a glassful of milk, only two persons can be said to have ingested it in any quantity.

One, *the Mr. Thompson* who purchased the goats and had been taking the milk for some time, died rather suddenly in January, 1906, of what was diagnosed bilateral pneumonia following influenza. No *post-mortem* was made, and no blood was obtainable for making an agglutination test with *Micrococcus melitensis*.

With regard to Mr. Thompson, the captain of the "Joshua Nicholson" considers that he was "sickening for something" at about the same time as himself and with very similar symptoms, namely, slackness and anorexia. Mr. Thompson himself said it was "liver."

The steward states that he did not notice anything definitely wrong with him, but that his appetite was poor during the entire voyage. From his physician's report, however, it would appear that on arrival in America he was perfectly well.

The other person, an unnamed *female* living in Athenia, N.J., who had been drinking mixed milk from several goats daily for a considerable but not very definitely known period, became sick in December, 1905, with Mediterranean Fever, diagnosed by the clinical symptoms, and the fact that her blood serum yielded a positive agglutination reaction with *Micrococcus melitensis.*

Epidemiological Observations.

In the "Joshua Nicholson."—The ship is the usual type of cargo steamer built in 1880, of 1853 tons gross (1196 tons net), 270 feet in length by 35 feet in breadth, with a raised poop and forecastle containing living spaces for officers and crew respectively, and in the waist two hold spaces separated by the engine and boiler rooms. Amidships there are deckhouses for the accommodation of part of the officers and crew.

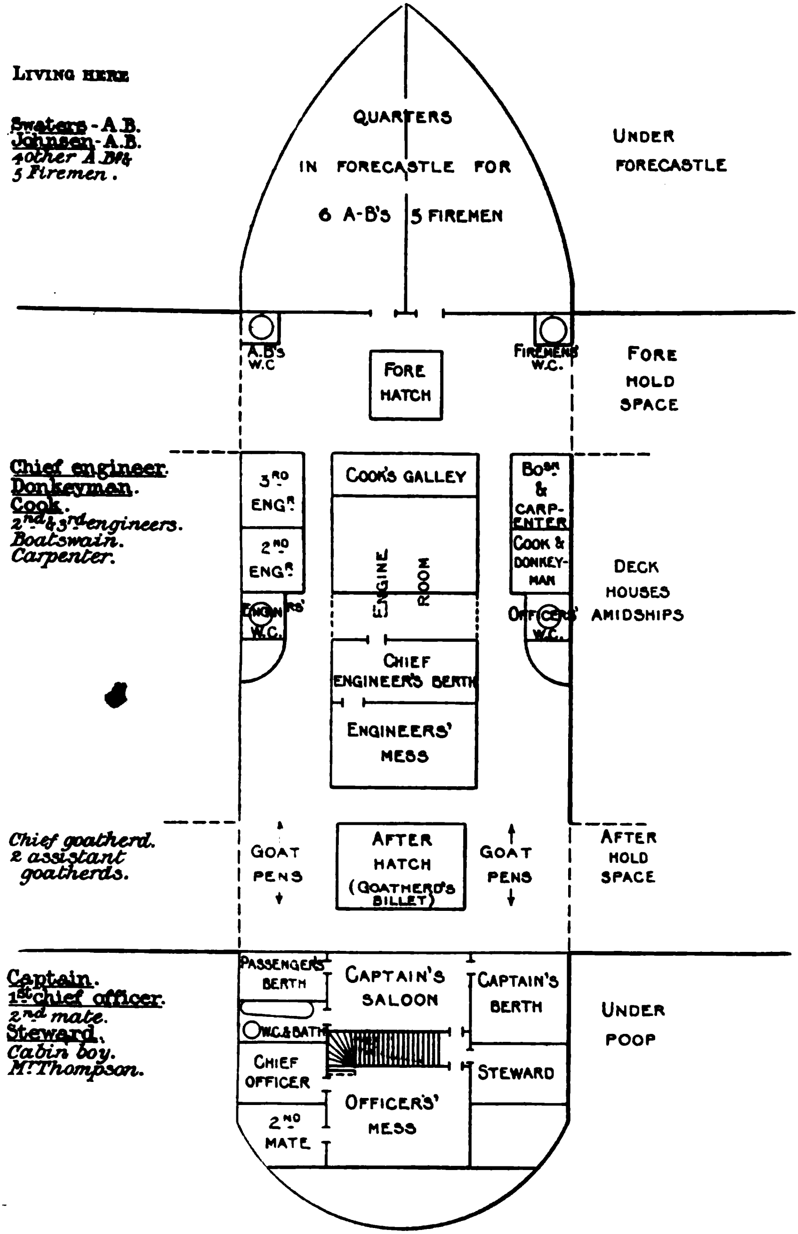
There are, therefore, three separate portions of the ship utilised as living spaces, and it will be instructive in connection with the possibility of contact infection to consider in more detail the persons inhabiting these various portions, and the incidence of illness among them. It will, however, be as well to indicate first the possible sources of infection and their position during the trip.

The Possibility of Contact Infection.—Mr. Thompson had spent some months in Malta, and may possibly have contracted the disease there and been suffering from its effects during the voyage; he lived aft under the poop, in a sleeping cabin on the port side of the captain's cabin, the latter's own sleeping cabin being on the starboard side.

The three goat-herds were natives of Malta, most probably had already had an attack of Malta Fever, and may quite conceivably have been excreting *Micrococcus melitensis* in the urine, or, judging from Shaw's work on the ambulatory type of the disease, had the organism circulating in their blood. It has only been possible to obtain the chief goat-herd's blood for examination (the other two goat-herds being still in America), but this gave a very marked reaction in a dilution of 1 in 20. A specimen of his urine was also obtained and plated, but no *Micrococcus melitensis* could be detected.

All three goat-herds messed and slept on the after hatch close alongside the goats.

Lastly, there were the goats, which, as has already been stated, lived in pens placed in the waist, abaft the engine-room and over the after holds. How many of these animals were passing *Micrococcus melitensis*



Sketch-plan of s.s. "Joshua Nicholson," showing positions where the various persons in the ship, during the voyage from Malta to Antwerp, messed and slept. Names underlined are known to have subsequently developed illness, and in five at least out of the number this was verified as Mediterranean Fever by the agglutination reaction.

either in urine or milk or in both during the voyage it is impossible to say.

Localisation of Cases.—Under the poop in the aftermost part of the ship there was, abaft the captain's cabin, where he and Mr. Thompson lived, the officers' mess, inhabited by the first and second mates. The steward and his brother, the cabin boy, also had their meals and slept in a cabin down here.

Of those living in this part of the ship, therefore, the captain, first mate and steward contracted the fever, verified in all three cases by the agglutination reaction; while the second mate, cabin boy and, presumably, Mr. Thompson escaped.

Amidships was the chief engineer's cabin, and the engineers' mess; on one side were the quarters of the donkey-man and the cook, while on the other side and a little further forward the two engineers, the carpenter and boatswain were berthed.

Of the people living in this portion of the ship, therefore, who still remained in her after leaving Antwerp, the chief engineer, donkeyman, and cook, were all ill, and the two engineers escaped. Only in one of these cases has the diagnosis been verified by the agglutination reaction, viz., that of the chief engineer, whose blood still reacted 1 in 80 when examined in July, 1906.

Forward under the forecastle were the quarters for five firemen and six seamen. Of these, two seamen, Swaters and Johansen, are known to have been ill; in the former case the diagnosis of Malta Fever being verified by the agglutination reaction; the remainder of the men left the ship at the same time as the goats, and have since been lost sight of.

Infection from Urine.—Although no *Micrococcus melitensis* was recovered from the chief goat-herd's urine in the one examination made, this by no means negatives the possibility that he was passing the organism in his urine in August, 1905. Of the persons, however, who might have been excreting infective urine, one, Mr. Thompson, would use the officers' latrine, while the goat-herds would make use of the men's. Similarly, the distribution of illness among those attacked would not incriminate any one latrine. As regards the risk of infection from the goats' urine, one would expect the barefooted seamen who also scrubbed the deck to be more liable to inoculation than the booted officers. Convection by flies is of course a possibility, but as the ship sailed at once, it is decidedly unlikely that flies or other insects remained long on the upper deck where the goats were located.

Infection from Biting Flies.—Though possible, the distribution of the cases in all parts of the ship, and the fact that she was only a few hours in Malta, moored in the stream, and put to sea at once, renders this distinctly improbable.

Infection from Ingestion of Milk.—This is the one common factor, and its probability is immensely strengthened by the two facts that all who are known to have taken little milk, or to have boiled the milk before drinking it, escaped, and that one of the only two persons who drank it to any extent in America, far from the endemic area and almost removed from the possibility of contact infection, contracted a typical attack.

At Antwerp.—It is difficult to understand why the persons who drank the milk at Antwerp escaped infection. It must, however, be remembered that it was taken at the most for a period of five days, and that two separate informants in the "Joshua Nicholson" say that the goats had largely ceased to secrete milk at the end of the trip from Malta. As the Micrococcus could only be isolated from the milk of two when first examined in America (in November, two months after arrival), it does not seem improbable that those passing the cocci should either have ceased to do so at this time, or that the number excreted should have very greatly diminished. Moreover, it is not altogether unreasonable to suppose that these animals, infected by the Micrococcus and not therefore in a normal condition of health, would be among the first to respond to any conditions adversely affecting the secretion of milk.

In the "St. Andrew."—This is far more difficult to explain, but certain facts must be taken into consideration. In the first place, the voyage was one across the Atlantic, and more stormy weather was met with than in the "Joshua Nicholson." In the second, the ship was no longer in the subtropics, but in wintry northern seas, and, finally, the goats were below in a stuffy hold and not on the upper deck.

The possibility that the secretion of the milk was interfered with is, therefore, considerably greater than in the "Joshua Nicholson." Again, the number of persons amongst whom the milk was distributed was almost three times as large as that comprising the crew of the "Joshua Nicholson," consequently the amount of milk available per head, even supposing the goats were yielding as well, would be much diminished.

In America.—In this case there was no possibility of previous exposure, and infection by contact is far less probable than in the ship. Mr. Thompson went to Washington the day after arrival, so that he, as a possible source of infection, can be disregarded. The goat-herds and the goats themselves were at the quarantine station, but the patient could not have been exposed to the same chances of contact infection as those in the ship. On the other hand, there is the positive evidence that she had drunk a considerable amount of milk from various goats of the herd, and that this probably insluded infected milk.

Duration of Period between Ingestion of Goats' Milk (some of which was

undoubtedly infective) and the Development of Symptoms.—Assuming milk to be the vehicle of infection, the following table gives the interval in days which intervened between the time during which the milk was being consumed and the first development of symptoms in the three cases in which this latter point is definitely known.

Table.

Name.	Dates of ingestion of milk.	Date of onset.	Interval.
D. Smart	Between Aug. 19 and Sept. 1	Sept. 19	31 to 18 days
F. Jenkins......	" "	" 19	31 " 18 "
Swaters	" "	" 22	34 " 21 "

In conclusion, I have to acknowledge the kindness of Mr. Grout, of the American Consular Service in Valletta, who not only first enabled me to see the chief goat-herd and trace the goats, but also gave me much assistance otherwise. I am also indebted for much information to Dr. A. D. Melvin, Director of the Bureau of Animal Industry, U.S.A.; to Messrs. O. F. Gollcher, agents for the Westcott and Lawrence line in Valletta; to Captain Cherry, the chief engineer and steward of the "Joshua Nicholson"; to Messrs. Rankin, Gilmour and Co., the owners, and Captain Fitzgerald, the master of the "St. Andrew"; and to Sir Cecil Hertslet, His Majesty's Consul-General at Antwerp, who has been kind enough to obtain the information required in that place.

Division II.—MILITARY.

By Major T. McCulloch, M.B., and Major J. C. Weir, M.B., Royal Army Medical Corps.

SYNOPSIS OF CONTENTS.

PAGE
Section I.—Introductory—Statistical Data, etc. 123
1. Continued fevers in Malta from 1861 to 1905 124
(1) Relation to sanitary conditions 127
(2) Relation to strength of garrison 128
(3) Cyclical periods 129
(4) Extent of prevalence of continued fevers 131
(5) Comparison of Malta and Gibraltar 131
2. The period of separate statistics 134
(1) The prevalence of Mediterranean, simple continued and enteric fevers in Malta from 1897 135
(2) The relation of simple continued fevers 136
(3) The relation of enteric fever 142
(4) Prevalence of Mediterranean Fever in Malta from 1897 to 1905 144
3. Prevalence of Mediterranean Fever in different branches of the service 150
(1) Artillery and infantry compared 150
(2) Special prevalence in the Royal Army Medical Corps 150
(3) Interval between arrival of units and first appearance of cases 157
(4) Prevalence amongst officers, women and children 158
(5) Age and service in Malta in relation to Mediterranean Fever 160
(6) Climate in relation to Mediterranean Fever 162
Section II.—Mediterranean Fever in the Garrison in 1906 163
Preliminary remarks 163
1. Drainage, barrack supplies, etc. 165
2. Investigation of milk supplies 166
(1) Milk precautions prior to the milk change 168
(2) Failure of sterilisation 169
(3) Laboratory examinations of milk 170
(4) Cases with a common milk supply 170
(5) Examinations of goats 170
(6) Discontinuance of the use of goats' milk in hospitals and barracks 172
3. Distribution of cases 174
4. Prevalence in units 177
5. Analysis of cases 179
(1) Series 1.—The cases in the 1st Battalion Royal West Kent Regiment 181
(2) Series 2.—The cases in the Royal Army Medical Corps 192
(3) Series 3.—Hospital cases 195
Examinations of the diet sheets of patients in Valletta Hospital during 1905 201
(4) Series 4.—Other cases of possible milk infection 205
(5) Series 5.—Cases in which the patients were probably infected through animals other than goats 208
6. Occupation in relation to attack 209
7. Prevalence amongst officers 210
8. Prevalence in married quarters 211
9. Mosquitoes, etc. 213
10. Preventive measures 214
11. Results of work in 1906 218

Division III.—CIVIL.

PAGE

1. Prevalence amongst the civil population 227
2. Age and sex in relation to attack 228
3. The relation of goats to the incidence of the disease 233
4. Goats' milk as a factor in the causation of Mediterranean Fever amongst the civil population. By Dr. A. Critien, of the Public Health Department, Malta 235

GENERAL SUMMARY.

i. The incubation period 244
ii. A critical examination of naval, military, etc., observations 250
iii. Recommendations 256

Division II.—MILITARY.

Section I.

The view is still current in Malta that Mediterranean Fever is, comparatively speaking, a disease of recent appearance in the island. The old contention that it was introduced by troops from the Crimea appears to have died out, but it is still asserted by some that the disease originated when the new drainage system was laid down in 1885. Hughes quotes evidence in his historical account of the disease which goes to show that, although unrecognised as a separate entity, it was one of the diseases of Malta as far back as the beginning of last century, and it is possibly of much greater antiquity. An old manuscript book in the Principal Medical Officer's office at Malta contains a health report, dated June, 1818, in which the surgeon of the 8th King's Regiment of Foot states that the regiment landed in Malta on March 2, 1818, and took up quarters in the barracks at Floriana. Soon afterwards, cases of fever began to occur, one or two being of great severity, and the description given of the symptoms bears a close resemblance in many respects to the disease as described at the present day. That Mediterranean Fever formed one of the diseases included under the heading of continued fevers in the period 1861—1870 is certain. For example, it is noted in the Army Medical Department Report for 1866 that the fevers of the year were characterised by tedious convalescence and the frequent occurrence of orchitis and rheumatism as sequelæ. It may be worth mentioning here that Hennen, who was in Malta from 1816 to 1825, in his book on the "Medical Topography of the Mediterranean," draws attention to the fineness of the goats in Malta, and to the excellence of the milk they furnished.

No attempt was made in the writings of the earlier army medical officers to distinguish Mediterranean from other fevers of continued type, and it was only after the Crimean War that the distinction began to be made. The first accurate description of the disease was given by Marston in the Army Medical Department Report for 1861, under the

heading of Mediterranean remittent or gastric remittent fever. The discovery of the *Micrococcus melitensis* in 1887 definitely established the fact that Mediterranean Fever was a distinct disease, and this was recognised by its being included in the official Nomenclature of Diseases in 1897, from which year it was given a separate place in army statistical returns. It should not be lost sight of, however, that long previous to this a very exact knowledge of the clinical features of the disease had been gained from years of observation of cases; for example, Bruce was able to obtain records of the admission of 627 cases to Valletta Hospital during the 12 years 1876 to 1887. Prior to 1897, Mediterranean Fever was included with simple continued fever in official returns under the heading of "Other Continued Fevers," enteric having been shown as a separate disease since 1882, before which year the heading of "Continued Fevers" included enteric, Mediterranean and simple continued fevers. Consequently, although records of enteric prevalence can be obtained as far back as 1882, records in which Mediterranean and simple continued fevers are separately shown only begin with the year 1897. It follows that, in making comparisons of recent with old statistics, it is necessary to do so on a "Total of Continued Fevers" basis.

Mediterranean Fever statistics require to be brought up to date, as, up to the present, the only readily available compilations are those given by Hughes, ending with 1895, and published in his book in 1897. Hughes' tables deal with the periods when it was impossible to split up "Continued Fevers" into the component parts, and they end at a time when the prevalence of continued fevers appeared to be on the decrease, whereas they have since shown a strong upward tendency. A considerable amount of attention has, therefore, been given to statistical details, and particularly to those of the period beginning with 1897, when separate Mediterranean Fever statistics were first obtainable.

1. *Continued Fevers in Malta from* 1861 *to* 1905.

The earliest statistical data relating to the prevalence of continued fevers in Malta which we have been able to find are for the period 1813 to 1818, when the admission rate was 89·1 and the death rate 1·88 per 1000. As time went on, continued fevers manifested a steadily increasing prevalence amongst the troops. Thus, in the decennial period 1836—1847, the admission ratio had risen to 207·3 per 1000, with a death rate of 1·46. In 1859, the prevalence of these fevers reached its culminating point with an admission ratio of 269·5, and this is still the highest on record; the same is true of the death rate, which was 8·85 per 1000. The following comments appear in the Army Medical Department Report for the year:—"Although there has been a slight increase in paroxysmal fevers and rheumatism, the great

difference, both in the number of cases and deaths, has been attributable to fevers of the continued type. The excess in 1859 over the previous average amounting to 62 per 1000 in the admissions, and 7·4 per 1000 in the deaths. The disease appears to have become more than usually prevalent in the second quarter of the year, to have reached its maximum in the third, but to have caused the greatest number of deaths in the fourth quarter. The fever was of typhoid type, and of a very fatal character, the deaths amounting to 1 in 28 of all the cases, while in the 23rd Regiment they were as high as 1 in 20, and in the 4th Rifle Brigade 1 in 18. On the average of the 10 years 1837—1846, continued fever proved fatal to only 1 in 141 cases." The high mortality and its occurrence at the close of the year indicate an enteric epidemic grafted on to the ordinary fever prevalence. Of the six regiments, the only corps which appears to have enjoyed a marked exemption from the disease was the 1st Battalion 21st Regiment, the only old battalion serving in the island, while by far the highest proportion of admissions, but with a moderate death rate, occurred in the 2nd Battalion 22nd Regiment, which arrived from England in the end of May, just as the hot weather set in. Overcrowded barracks and a hot dry season were accompanying conditions.

The following table shows the prevalence of "Continued Fevers" in Malta up to the end of 1905. For purposes of comparison, the ratios of admissions from all causes are given, as well as the corresponding statistical data relating to Gibraltar. The ratios are arranged in decennial periods from 1861 to 1900, followed by the quinquennial period 1901 to 1905.

Table I.

Malta.

Period.	All causes. Ratio per 1000. Admissions.	All causes. Ratio per 1000. Deaths.	Continued fevers. Ratio per 1000. Admissions.	Continued fevers. Ratio per 1000. Deaths.	Proportion of continued fevers to admissions from all causes.
					per cent.
1813—18	—	—	89·1	1·88	—
1837—46	—	—	207·3	1·46	—
1859	1213·9	19·02	269·5	8·85	22
1860	983·0	10·59	208·6	3·87	21
1861—70	798·1	13·49	172·7	3·09	22
1871—80	857·1	9·77	155·3	2·56	18
1881—90	698·7	8·70	122·4	3·36	17·5
1891—1900	784·7	7·56	171·6	3·58	22
1901—05	640·1	6·32	174·3	2·50	27
Ratios 1861—1905	762·2	9·13	159·8	3·09	21

Gibraltar.

Period.	All causes. Ratio per 1000. Admissions.	All causes. Ratio per 1000. Deaths.	Continued fevers. Ratio per 1000. Admissions.	Continued fevers. Ratio per 1000. Deaths.	Proportion of continued fevers to admissions from all causes.
					per cent.
1813—18	—	—	—	—	—
1837—46	—	—	75·5	1·87	—
1859	949·0	7·18	107·5	2·91	11
1860	825·0	11·06	59·4	1·07	7
1861—70	742·5	8·44	72·9	1·60	10
1871—80	675·8	6·66	87·9	1·23	13
1881—90	800·4	6·01	108·9	2·24	13·6
1891—1900	718·6	4·00	20·3	1·01	2·8
1901—05	362·8	3·71	9·6	0·59	2·7
Ratios 1861—1905	692·9	6·01	65·1	1·42	9·4

The chief points which this table brings into prominence are as follows:—

1. The great prevalence of continued fevers in Malta.
2. The increase in prevalence in recent years.
3. That, although the general decennial admission ratios (all causes) show comparatively little change since 1861, there has been a gradual but steady decrease in the corresponding death rates.
4. That the decennial death rates from continued fevers for the same period show no improvement.
5. That the health of the garrison of Malta compares unfavourably with that of Gibraltar, especially as regards prevalence of continued fevers.
6. That there has been a remarkable disappearance of fevers of continued type (except enteric) from Gibraltar, and this has taken place in the course of the last 20 years.

Concerning the increase of continued fevers which occurred in the second and part of the third quarters of last century, reaching its highest point in 1859, we have nothing to say. The thirty years 1861—1890 are marked by a decreased prevalence of continued fevers, as evidenced by ratios of 172·7, 155·3, and 122·4, for the successive decennial periods. The next fifteen years showed a very considerable increase in fever prevalence, the decennial ratio for 1891—1900 being 171·6 per 1000, and this was followed by a further increase to 174·3, the average rate observed during the five years 1901 to 1905. During the thirty years' period of decrease the strength of the garrison averaged

about 5200, while the average strength for the ten years 1891—1900, was about 7800, and for the five years 1901—1905 just over 8000. At the close of the second decade of the period of decrease an unsettling factor is introduced into the question, namely, the short service system, which would cause a greater circulation of men and, therefore, a corresponding increase in the quantity of susceptible material. A reference to Chart 1 will show that this change was associated with increased prevalence of enteric fever. Indeed, during the four years, 1882—1885 enteric fever was higher than it has ever been either before or since. But the change does not appear to have exercised any immediate effect on the prevalence of the other continued fevers, *i.e.*, simple continued and Mediterranean Fevers. In fact, three of the years when enteric was so prevalent, 1882—1884, are years when the prevalence of the other continued fevers was light, while the five years 1887—1891 are remarkable as being the years showing the lowest prevalence of continued fevers which has occurred during the entire period from 1861 to 1905.

(1) *Relation to Sanitary Conditions.*—That a factor altogether outside ordinary sanitary defects must exist to account for the increase in prevalence of continued fevers in recent years seems more than probable, when it is considered that the soldier must have been living under far better conditions, and with far better sanitary surroundings, during the fifteen years 1891 to 1905 than those that obtained during the greater part of the thirty years 1861 to 1890. Yet, the 1891 to 1905 period was marked by a largely increased prevalence of these fevers. In the Army Medical Department Report for 1861, the following comment is made, in a reference to the opening of new stone barracks at Pembroke Camp, St. George's Bay, "that they must prove a valuable relief to the hitherto densely packed garrison of Malta." And, in connection with the erection of two wooden huts at Upper St. Elmo, we are informed, that they were much required, for the barracks, *generally, throughout the garrison*, are imperfect in their means of ventilation, limited in respect of their cubic space, objectionably situated for their health as an especial question, and had imperfect drainage. In another part of the report, the Principal Medical Officer, when reviewing the sanitary conditions generally, remarks that, barracks being throughout the command within the lines of fortification, old structures built by the "Knights" and connected with the defences, they are ill-ventilated and often damp, and much of the disease which occurs in the garrison is engendered by them. Consistent with their present construction, although capable of much improvement, it is thought they never can be placed on a high sanitary footing suitable to the climate; and he advances for consideration, whether the erection of quarters outside the walls, for occupation in time of peace, would not be attended with satisfactory

results, not only in a sanitary, but also in a financial view. The barracks, at this time, are also described as cheerless, badly lit and ill warmed. From very early days the overcrowded barracks were relieved in the hot season of a portion of their occupants by pitching tents, and it is several times recorded that this measure always appeared to be followed by a lessening of sickness in the barracks concerned, while it is also stated that the type of case from the tents was less severe than cases from the barrack rooms. Such, then, were some of the conditions under which soldiers were living in the early part of the thirty years' period of decreased fever prevalence, and, although sanitary improvements were made in those old barracks as years went on, no new barracks were opened between 1861 and 1896. Towards the close of this period two great sanitary advances were made, in the remodelling of the drainage of Valletta in 1885, and in the provision of a better water supply in 1887. New barracks were built and were opened at Imtarfa in 1896, Tigne in 1901, New Floriana (A, B, and C blocks) in 1903 and St. Andrew's Barracks, Pembroke, in 1905. Yet, notwithstanding general sanitary improvements in old barracks and the provision of new barracks, and that the clothing and feeding, as well as the general environment of the soldier have been altered greatly for the better since the sixties and seventies, continued fevers increased in prevalence during the decennial period 1891 to 1900, and increased still further in the five years 1901 to 1905, the ratio for the latter period being 174·3 per 1000, or 1·6 higher than the decennial ratio of 1861 to 1870. Even granting that there was still much sanitary deficiency remaining in the 1891 to 1905 period, surely it cannot be maintained that the sanitary conditions were worse than in the preceding thirty years. That sanitary improvements were exercising a beneficial effect on the general health conditions of the troops is rendered evident by consideration of the death rates from all causes (Table I), from which it will be observed that the death rate of 13·49 per 1000 for the decennial period 1861 to 1870 had fallen to 6·32 per 1000 for the five years 1901 to 1905, and that the descent has been gradual and progressive for each succeeding decennial period. Table I also shows that there has been no corresponding decrease in the fever death rates, in fact there has been little or no change, which consideration appears to indicate that sanitary improvements have not exerted any influence in diminishing the severity of type of these fevers, and, as we have seen, the incidence has increased.

(2) *Relation to Strength of Garrison.*—As already pointed out, there was a very marked difference in the strength of the garrison in the two periods. The annual average strength for the period from 1861 to 1890 was about 5200, while for the 10 years 1891 to 1900 it averaged about 7800, and for the five years 1901 to 1905 just over

8000. On examination of the yearly strengths from which these averages are calculated, it is observed that for by far the greater part of the thirty years' period the annual strength was generally under 5000 men, and often considerably under that number. In 1887 the strength began to be increased, the average strength for that year being 5499, and each year troops were added gradually to the garrison until a strength of 7055 was reached in 1890, of 7847 in 1892, and of 8292 in 1895. As no new barracks were available until 1896, accommodation for the additional 2000 to 3000 men had to be found in existing barracks, which may have meant overcrowding. Nothing happened during the first three years, 1887 to 1889, in fact they were exceptionally healthy years. But in 1890, when the strength had reached just over 7000 men, enteric fever became more than usually prevalent, and there was large enteric prevalence in 1893. The sustained increase of the continued fevers, as a whole, dates from 1892.

(3) *Cyclical Periods.*—Hughes has pointed out that continued fever prevalence appears to run in definite cycles, and he defines a cyclical period as the period which extends from one maximum year of prevalence to the next maximum year. Chart 1 shows that the years of maximum prevalence were 1859, 1867, 1872, 1879, 1885, 1892, 1898, and 1905, the intervals being eight, five, seven, six, seven, six, and seven years respectively. The first five of those cyclical periods showed decrease, the last two increase of fever prevalence. We are unable to give any exact evidence as to what determines this apparent periodicity. We do not know which of the forms of continued fever have played the chief part in it, or whether they have all had a share. We know that cyclical prevalence is observed in other diseases, and it may be the case here also, that after the main part of the susceptible material, present for the time, has been used up, an interval must pass during which fresh material is accumulating. In a military station like Malta there is necessarily frequent movement of troops; regiments and drafts are constantly coming and going. New arrivals probably always bring a fresh accession of susceptible material. In some years there is less fluctuation than in others, and the garrison is for a short period correspondingly more stable. It is easy to understand that at some periods there may be unusually large accumulations of susceptible individuals, but it is thought that this would be more likely to show itself in a military population by irregular outbursts rather than by more or less well defined cycles. For example, Chart 1 shows an outburst of fever in Gibraltar during the years 1881 to 1885, which may have been contributed to by an unusual accession of susceptible individuals. We are told, in regard to one of the years, that the garrison contained many young soldiers, and the increase of fever in the years in question occurred in a period

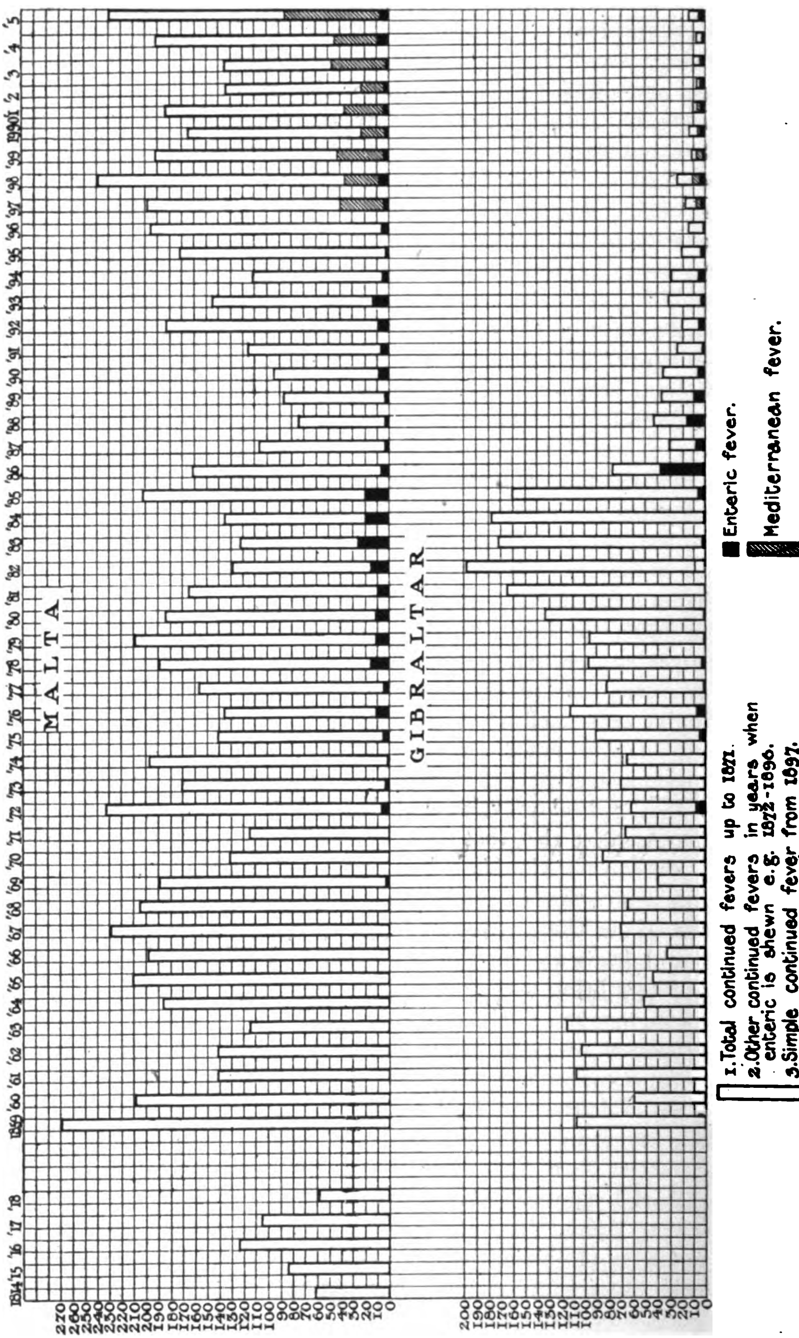


Chart 1.—Continued fevers—Malta and Gibraltar, 1850—1905.

shortly after the introduction of the short service system. Attention should be paid to the fact that cyclical periodicity is not a feature of the Gibraltar part of this chart.

(4) *Extent of Prevalence.*—During the forty-five years 1861 to 1905 the continued fevers (simple continued, Mediterranean, enteric) have been the cause of 21 per cent., or just over one-fifth, of the total admissions to hospital from all causes in Malta, and they have also been responsible for just over one-third of the total number of deaths. In Gibraltar, for the same period, these fevers have been the cause of 9·4 per cent., or just less than one-tenth, of the total admissions to hospital, and they have caused about one-fourth of the total deaths.

(5) *Comparison of Malta and Gibraltar.*—The general health of the garrison of Malta also compares unfavourably with that of Gibraltar (*vide* Table I). The decennial admission ratios from all causes are lower in the case of the latter, except for the decennial period 1881 to 1890, when the ratio was 800·4 per 1000 for Gibraltar against 698·7 for Malta. The Gibraltar death rates are uniformly lower than those of Malta. It is a notable circumstance that the ten years 1881 to 1890 show the highest prevalence of continued fevers on record for Gibraltar, whereas it was the period when the prevalence of these fevers was at its lowest point in Malta.

It will be observed (*vide* Table I) that commencing with the decennium 1861 to 1870, the prevalence of continued fevers in Gibraltar showed steady increase from 59·4 per 1000 until it reached 108·9 in the ten years 1881 to 1890, so that increase was the order of things in Gibraltar during the thirty years that decrease was occurring in Malta. In Gibraltar, during the first five years of the 1881 to 1890 period, there was a remarkable increase in prevalence of continued fevers, which then reached the highest point ever observed in this station, the highest ratio on record being that of 197·9 per 1000 for 1882, while the ratio for 1881 was 164·3, and the ratios for 1883, 1884, and 1885, were 171·4, 176·8, and 160·0, respectively. The increase appears to have been chiefly in continued fevers, other than enteric, as, although enteric was rather more than usually present in 1882 and 1885, no special enteric prevalence was observed in 1883 or 1884. During the second five years of this period the very opposite was observed. In 1886, a large outbreak of enteric fever occurred, regarding which it is stated, that the disease was introduced by a regiment which had lately come form Egypt to Gibraltar, and for the next three years enteric was unusually prevalent. During these four enteric years there was a great lessening of the other continued fevers, their prevalence being reduced to about one-fifth of what it was for the four immediately preceding years, 1882 to 1885. The figures for the decennial period are as follows :—(see also Chart 1).

Gibraltar, 1881—1890. Ratios per 1000.

Year.	Enteric fever.	Other continued fevers.	Total continued fevers.
1881	Not known	Not known	164·3
1882	8·8	189·1	197·9
1883	2·5	168·9	171·4
1884	0·6	176·2	176·8
1885	5·7	154·3	160·0
1886	36·7	40·2	76·9
1887	7·6	22·7	30·3
1888	15·4	27·7	43·1
1889	9·0	28·8	37·8
1890	5·6	30·5	36·1

Absolutely certain evidence as to the cause of the great increase of fever prevalence during the first half of this decennial period is, as might be expected, impossible to obtain, but it may be stated that it coincided in point of time with the introduction of the short service system, and Horrocks, in his paper on "Mediterranean Fever in Gibraltar" (Part V of the Commission Reports) points out the significant fact, that in 1883 practically all the goats on the Rock were Maltese, and also, that at that time regular shipments of goats from Malta to Gibraltar took place.

In Chart 1 the prevalence of continued fevers in Malta and Gibraltar from 1859 to 1905 is contrasted, and a most extraordinary contrast is observed between the fever records of the two Mediterranean stations during the twenty years 1886 to 1905. In that time, Mediterranean Fever has almost completely disappeared from Gibraltar, and coincident with its disappearance there has been a most remarkable lessening in the prevalence of simple continued fevers. On the other hand, in Malta, during the same period, there was very great prevalence of these fevers.

The disappearance of these fevers from Gibraltar began somewhat abruptly in 1886 and, as already stated, 1886 particularly, and the three following years to a less extent, were years in which enteric was more than usually prevalent. Since that time up to 1905, although the enteric ratios have been moderate, the prevalence of the disease has been steady. The conditions, therefore, which were bringing about the disappearance of Mediterranean and simple continued fevers were apparently not affecting to any considerable extent, if at all, the prevalence of enteric. It seems worth noting here that the Army Medical Department Report for 1892 gives the information that all the milk for the troops in Gibraltar was then being boiled as a preventive measure against enteric fever.

The following are the ratios for Mediterranean, simple continued

and enteric fevers for Gibraltar from 1897, the year from which the statistics are first given separately in army returns:—

Gibraltar, 1897—1905. Ratios per 1000.

Year.	Mediterranean Fever.	Simple continued fever.	Enteric fever.
1897	4·0	10·1	3·4
1898	6·3	11·2	4·2
1899	4·2	4·7	2·1
1900	2·0	6·8	4·3
1901	2·4	4·1	3·6
1902	1·0	2·2	3·1
1903	1·9	5·8	2·3
1904	—	4·8	2·9
1905	0·7	9·1	4·1

It will be observed from a consideration of these ratios, or, better still perhaps, by a glance at Chart 1, that there was a second small, but still well marked, decrease of Mediterranean fever prevalence in 1900 in Gibraltar, that the ratio was very low in the next three years, and that there were no cases at all in 1904. The ratio of 0·7 for 1905 represents only three admissions for the disease, and in regard to two of the cases it was stated that the men had lately arrived in a draft from Malta, and had in all probability contracted the disease there. The third was a man employed as a military policeman, who had been in Gibraltar for five years, and in this case the probable source of the disease could not be traced. In 1906 there have been no cases of Mediterranean Fever in Gibraltar up to the end of November.

The simultaneous disappearance of so much of the simple continued fever seems to indicate that a common factor, or factors, had been removed, or at any rate, greatly lessened, and also that many cases which were returned as simple continued fever may have been mild cases of Mediterranean Fever. The disappearance of Mediterranean Fever from Gibraltar is discussed by Major Horrocks in a paper (Part V, Commission Reports) already referred to, with which is a chart showing a probable connection between reduction of the number of infected goats and the decrease of fever. From this paper we obtain the two following important facts:—

(1) That, as a result of the withdrawal of grazing passes, the number of goats was reduced.

It was ascertained that from 1883 to 1893 about 1100 goats were sold.

(2) *Pari passu* with the withdrawal of grazing passes, and increase in the cost of shipment, importation of goats *from Malta* on a large scale ceased.

Goatkeepers replaced their stock partly by importation of Spanish goats, and partly by breeding.

Horrocks concludes his paper in the following words:—"It appears probable that the rapid disappearance of Mediterranean Fever from Gibraltar, which commenced in 1885, was intimately connected with the exodus of infected goats from the Rock. Improved sanitary conditions, especially the disconnection of waste-pipes and house-drains from sewers, may have played a part in causing the decrease of fever, but as the same sanitary improvements have been carried out in Malta without any corresponding decline of Mediterranean Fever, it is fair to assume that their effect was insignificant compared with that produced by the removal of infected goats."

2. *The Period of Separate Statistics.*

Table II gives the statistics of Mediterranean, simple continued, and enteric fevers for Malta from 1897.

Table II.

Year.	Average strength.*	Mediterranean Fever.		Simple continued fever.		Enteric fever.		Total continued fevers.	
		Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.
1897	8023	279	12	1275	—	34	15	1588	27
1898	7390	200	8	1509	1	62	24	1771	33
1899	7425	275	9	1107	—	41	17	1423	26
1900	8140	158	8	1158	—	31	11	1347	19
1901	8136	253	9	1205	—	41	11	1499	20
1902	8758	155	6	981	—	38	4	1174	10
1903	8903	404	9	781	—	18	8	1203	17
1904	9120	320	12	1350	—	79	16	1749	28
1905	8294	643	16	1199	—	64	17	1906	33
1906	6661	163†	1	504	—	9	1	676	2

* Excluding Crete. † Including 19 re-admissions.

Ratios per 1000 of Strength.

Year.	Mediterranean Fever.		Simple continued fever.		Enteric fever.		Total continued fevers.	
	Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.
1897	34·7	1·49	158·9	—	4·2	1·88	197·9	3·36
1898	27·1	1·08	204·2	0·13	8·4	3·25	239·6	4·46
1899	37·0	1·21	149·1	—	5·5	2·29	191·6	3·50
1900	19·4	0·98	142·2	—	3·8	1·35	165·5	2·33
1901	31·1	1·10	148·1	—	5·0	1·23	184·2	2·45
1902	17·7	0·68	112·0	—	4·3	0·46	134·0	1·14
1903	45·4	1·01	87·7	—	2·0	0·90	135·1	1·90
1904	35·1	1·32	148·0	—	8·7	1·75	191·8	3·07
1905	77·5	1·93	144·6	—	7·7	2·05	229·8	3·98
Ratios for 1897—1905	36·2	1·20	142·4	0·01	5·5	1·66	184·1	2·87
1906	24·5*	0·15	75·6	—	1·4	0·15	101·5	0·30

* Excluding re-admissions, the ratio is 21·6 per 1000.

(1) *Prevalence.*—An examination of the figures in Table II shows that there were 13,660 admissions for continued fevers, with 213 deaths during the nine years, 1897—1905, and that these were made up as follows:—

	Admissions.	Per cent.
Simple continued fever ...	10,565	77
Mediterranean Fever.........	2,687	20
Enteric fever	408	3

The death-rate for the nine years' period works out at 1·20 per 1000 for Mediterranean as compared with 1·66 for enteric fever. The percentage mortality to attack, in the case of Mediterranean Fever, was 3·3 per cent., against a percentage mortality for enteric fever of 30·1 per cent. A comparison of the Gibraltar figures for the corresponding period is of interest. They are as under:—

	Admissions.	Per cent.
Simple continued fever ...	277	52·6
Mediterranean Fever.........	107	20·3
Enteric fever	142	27·1

The strength of Gibraltar was over half that of Malta. The death-rate for Mediterranean Fever was only 0·07 per 1000, against 0·87 for enteric fever. For Mediterranean Fever the percentage mortality to attack was 2·9 per cent., and for enteric 26 per cent. It is curious to note that the proportion which Mediterranean Fever forms of the total continued fevers is practically the same as for Malta, and that the percentage mortality to attack is very similar for both.

(2) *The Relation of Simple Continued Fevers.*—The great prevalence in Malta of those indefinite forms of fever to which the designation "simple continued" has been applied is a very remarkable fact. We have seen that they constituted 77 per cent. of the total admissions for continued fevers during the nine years 1897 to 1905. Mild febrile attacks, dependent on a variety of causes, are of common occurrence amongst soldiers serving in hot countries, but Malta compares most unfavourably in this respect with every other garrison in which the British soldier is serving. The following table gives the comparative figures for the nine years 1897 to 1905, in the places named, which are given in order of prevalence:—

Table III.—Simple Continued Fevers.

	Total admissions, 1897—1905.	Ratios per 1000 of strength.
Malta	10,565	142·4
Egypt	2,471	64·6
Straits Settlements	574	62·2
Barbados (including St. Lucia)	346	48·2
India	17,988	30·5
Jamaica	162	29·9
Ceylon	371	27·8
Bermuda	258	15·7
South Africa—		
Four years before war, 1895–98	1,099	46·9
Four years after war, 1902–05	809	6·5
Hong Kong	17	1·3
Mauritius	5	0·7
West Coast of Africa	None	—
United Kingdom	1,793	1·9

Apart from the great prevalence in Malta of these "pyrexias of uncertain origin," as they are to be designated in the new "Nomenclature of Diseases," their undue prevalence has a direct relation to Mediterranean Fever. Many cases are admitted to hospital for simple continued fever in which the diagnosis has to be changed later to that of Mediterranean Fever. For example, in 1905, this happened in 100 instances. Over and over again, during our investigation of cases in 1906, the question of ascertaining the

exact period of onset of a case of Mediterranean Fever was rendered difficult, and sometimes impossible, by a history of a recent, or even a remote, previous febrile attack. A not uncommon type of case is for a man to be admitted for fever, but giving no serum reaction, and after a stay of a week or a fortnight in hospital he is discharged to duty as a case of simple continued fever. A week, or a fortnight, or a month later, he is again admitted with febrile symptoms, and often with a history of not having felt well or of having had rheumatic-like pains for either the whole or part of the interval. This time his blood is found to react, and the illness pursues the ordinary course of a case of Mediterranean Fever. Sometimes an attack may be preceded by two or more of these simple continued fever admissions. Or, again, there may be a history of a previous attack of fever, sometimes months before, and which may have caused a much longer stay in hospital than in the first type of case, but the clinical aspect was indefinite, and no serum reaction was obtained, and, consequently, the diagnosis of simple continued fever had to be made. On his second admission, the clinical appearances are unmistakable, the blood is found to give a typical reaction, and the case is returned as Mediterranean Fever. In some of these cases there is sometimes a connecting link between the admissions, in the shape of a history of the patient not having felt well since he was discharged from hospital after his first admission, or of having been more or less severely troubled by the rheumatic-like pains, which are so characteristic as sequelæ of an attack of Mediterranean Fever. The history in these cases leaves little doubt in the mind, that the second fever attack is a relapse rather than a first infection, and that the first admission, when simple continued fever was diagnosed, was the beginning of the patient's Mediterranean Fever. There can be little doubt, therefore, that many cases which have been returned as simple continued fever are in reality mild cases of Mediterranean Fever. This must necessarily continue to be the case as long as there is no certain means of distinguishing between these atypical cases and ordinary febrile attacks.

It will be seen from the following table that a considerable proportion of simple continued fever cases had a prolonged stay in hospital.

Table IV.—Classification of Cases of Simple Continued Fever, admitted to the several military hospitals in Malta, according to the number of days under treatment, for the years 1902—1905. The figures for 1906 are added for comparison.

Year.	Total number of cases.	5 days and under.	5 to 10 days.	10 to 15 days.	15 to 20 days.	Over 20 days.
1902	981	95	646	135	28	77
1903	781	79	457	142	52	51
1904	1350	194	867	184	49	56
1905	1199	223	676	189	50	61
Totals 1902–1905	4311	591	2646	650	179	245
Percentages ...	—	13·7	61·4	15·1	4·1	5·7
1906	504	124	311	43	11	15

It will be observed that, roughly speaking, 75 per cent. of the 4311 cases of simple continued fever admitted during the four years 1902—05 were cases requiring only a short stay in hospital, while 25 per cent. were cases of severer type, and 5·7 per cent. required over 20 days' hospital treatment. We have no exact knowledge as to the nature of the fevers represented in the last three of the five groups; many of them may have been mild or atypical Mediterranean Fever cases.

This Table also indicates that there was a large reduction in the prevalence of simple continued fevers in 1906, and especially in the 10 to 15 days, 15 to 20 days, and over 20 days, groups.

Another point which should not be lost sight of is the part which the ordinary febrile attacks may play in predisposing to attack by the severer diseases, Mediterranean and enteric.

Simple continued fevers exhibit a very decided, it might almost be called an abrupt, seasonal prevalence. A sudden increase occurs in June, prevalence reaches its highest point regularly in July, decrease commences in August, and a drop almost as sudden as the rise in June is observed with the close of September. Chart 2 (p. 140) shows the average monthly prevalence of simple continued fevers for the seven years 1899 to 1905, together with the average temperature and rainfall curves for the same period.

High prevalence of Mediterranean Fever in a unit is generally associated with high prevalence of simple continued fever cases, but a unit may have an unusual number of simple continued fever cases without any corresponding prevalence of Mediterranean Fever. The first hot

season that a regiment spends in Malta is usually marked by a high proportion of simple continued fever cases, and if it arrives close to the hot weather, or after the heat has set in, the greater is likely to be the prevalence of febrile attacks.

The barracks in which simple continued fevers have been most common in recent years have been as follows:—In 1902, Manoel, Cottonera Lines, and Lower St. Elmo barracks showed greatest prevalence. In 1903, Floriana barracks had most cases, and simple continued fever prevalence was associated with a very large outbreak of Mediterranean Fever affecting the 1st Battalion King's Royal Rifles. In 1904 a very great prevalence of simple continued fevers was associated with prevalence of both Mediterranean and enteric fevers in the 2nd Battalion Essex Regiment, which arrived in Malta from England on April 28, just at the beginning of the fever season, and were quartered in Lower St. Elmo Barracks; next in order of simple continued fever prevalence came Floriana, Verdala, Cottonera Lines, and Manoel, in all of which there was also a moderate prevalence of Mediterranean Fever, and in the three first-named barracks the occupants were newly-arrived regiments. In 1905 the greatest prevalence occurred in Lower St. Elmo, Cottonera Lines, Floriana, and Pembroke barracks, associated in all instances with marked prevalence of Mediterranean Fever. In 1906 Floriana was the barracks in which most cases were observed, and here, again, it was associated with prevalence of Mediterranean Fever. These facts would appear to indicate that simple continued fevers have a decided preference for the conditions obtaining in the old barracks, which are mostly in confined situations, and where, if overcrowding does occur, it is likely to have its worst effects. The preventive measure indicated is to spread out the men as much as possible in these old barracks during the hot weather months.

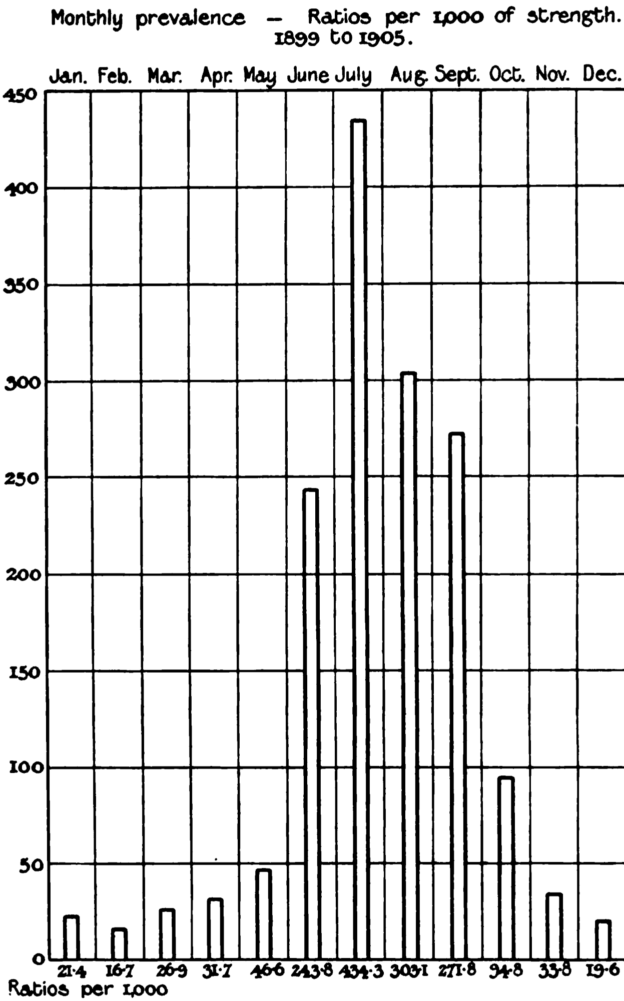
Much work still appears to be required in the direction of still further separating simple continued fevers into component parts—(1) in connection with the ordinary febriculæ, and (2) in connection with atypical cases of Mediterranean and enteric fevers, paratyphoid infections, etc.

To sum up, then, the following considerations appear to warrant the belief that a close relationship exists between many cases of simple continued fever and Mediterranean Fever, and that the bond is a common causative factor or factors.

1. The undue prevalence of simple continued fever in Malta as compared with garrisons in other warm climates.

2. The constant association of Mediterranean and simple continued fever prevalence.

3. The simultaneous disappearance of Mediterranean and simple continued fevers which has occurred in Gibraltar in the course of the last 20 years.



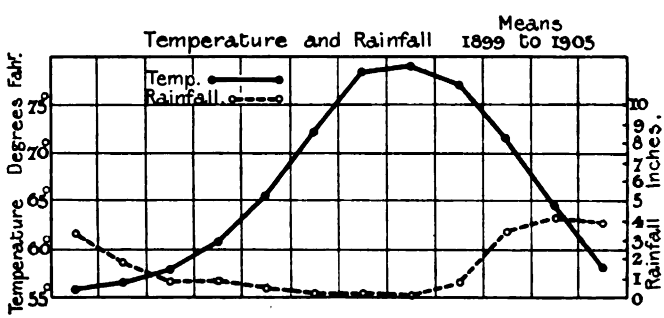


Chart 2.—Simple continued fever amongst the troops in Malta.

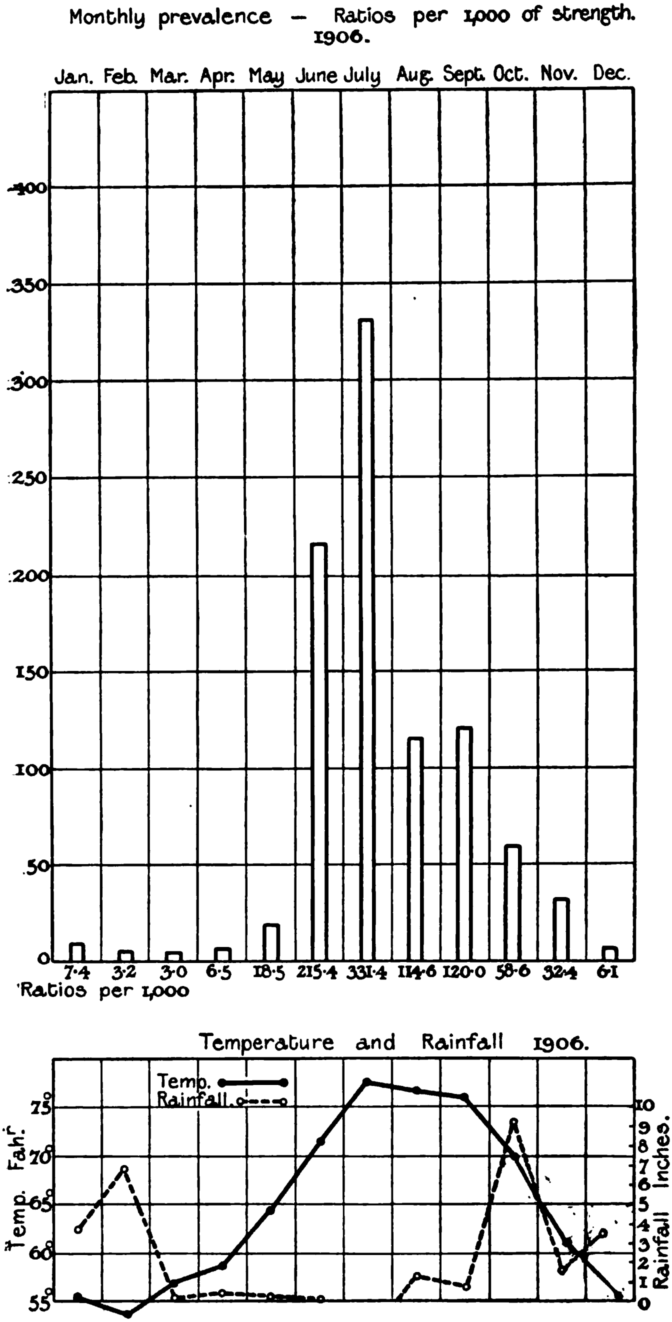


Chart 2.—Simple continued fever amongst the troops in Malta.

4. A similar reduction of simple continued fever prevalence has occurred during the second half of 1906 in Malta, in connection with a reduction of Mediterranean Fever prevalence. This will be referred to further in a later part of the Report. It is well shown in Chart 2 (p. 141).

(3) *The Relation of Enteric Fever.*—It is not uncommon to find Mediterranean, enteric, and simple continued fevers all prevalent at the same time and in the same areas. For example, the fever prevalence in the Essex Regiment in 1904 and 1905 was of this kind.

2nd Battalion Essex Regiment (arrived in Malta, April 28, 1904).

Month.	Mediterranean Fever.	Simple continued fever.	Enteric fever.
1904—			
May	—	—	1
June	7	67	1
July	19	226	3
August	20	35	1
September	18	44	1
October	7	4	6
November	7	2	2
Decemb e	1	3	6
1905—			
January	4	1	5
February	2	—	1
March	3	1	—
April	6	9	—
May	19	7	—
June	19	33	1
July	18	46	1
August	18	20	5
September	9	14	—
October	9	1	2
November	4	1	1
December	2	—	—

It will be observed that enteric was the first of the continued fevers to make its appearance among the men of this regiment, and that it began immediately on their arrival, but was most prevalent during the four months October to January, a period which had been preceded by a large outbreak of simple continued and Mediterranean fevers, and just as these fevers were beginning to show subsidence. Another example is a sharp outbreak of Mediterranean and enteric fevers which occurred in 1899, simultaneously, amongst the civil population of Rabato and the troops at Imtarfa barracks.

The following facts appear to show the existence of some relation between the two diseases, but it is a relation regarding which there is no very precise knowledge.

The *Micrococcus melitensis* and *B. typhosus* have both been recovered from the same case *post mortem.*

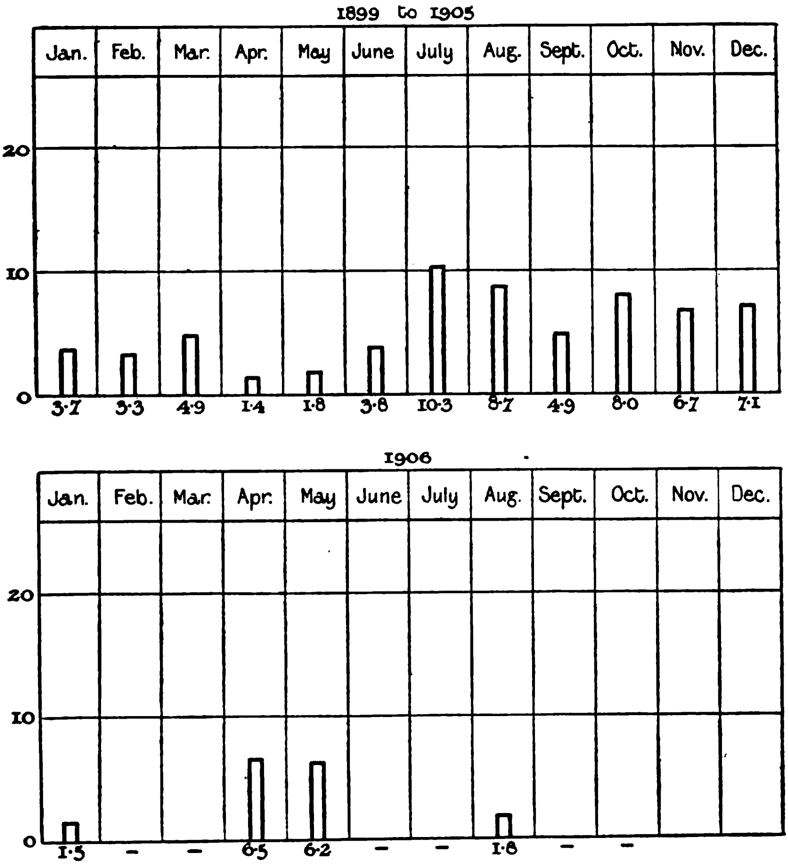


Chart 3.—Enteric fever amongst the troops in Malta.—Monthly prevalence.—Ratio per 1000.

In doing blood reactions in fever cases, the serum is not infrequently found to cause clumping of both *Micrococcus melitensis* and *B. typhosus*. We have a record of 74 instances of this occurring among the cases coming under observation in 1905 and 1906. In 24 of these instances there was a good reaction to both Mediterranean and enteric; in one instance only was the enteric reaction the more pronounced, and in the remainder the *Micrococcus melitensis* agglutination predominated. There is no reason why the two diseases should not be drawn from sources existing quite separately at the same time and in the same areas, but the frequent occurrence of cases presenting these double reactions seems curious.

Mediterranean Fever often supervenes on enteric, but in most such cases the possibility of a fresh infection having occurred presents itself.

There has been a complete absence of enteric fever in the garrison during the second half of 1906 (*vide* Chart 3), which is the part of the year when enteric usually prevails, and this corresponds in point of time with a considerable lessening in the ordinary prevalence of both Mediterranean and simple continued fevers.

(4) *Prevalence of Mediterranean Fever in Malta from* 1897 *to* 1905.—Table II (p. 134) shows that from the beginning of 1897 to the end of 1905 Mediterranean Fever caused 2687 admissions to hospital amongst the non-commissioned officers and men of the garrison, and there were 89 deaths. During the same period there were also 241 cases with three deaths amongst the officers, 310 cases with 20 deaths amongst soldiers' wives, and 145 cases with two deaths amongst soldiers' children. The total number of admissions in the garrison during the nine years was, therefore, 3383, and the total number of deaths 115, which figures give an admission ratio of 38·0 per 1000, and a death rate of 1·29. Invaliding from Malta on account of Mediterranean Fever is high, and must be a source of large expense to the State, as in the nine years under consideration it caused the invaliding of 128 officers and 1137 men.

Year after year, with unfailing regularity, Mediterranean Fever has manifested a widespread prevalence amongst the troops, cases being contributed each year by practically every corps, and a scattered distribution in barracks being the usual rule. In some years the distribution has been a general one, while in others the prevalence has been epidemic in character. An important feature of epidemic years is that the outbreak is usually confined to single, or sometimes one or two, units, while nothing more than ordinary prevalence is observed amongst the rest of the garrison; 1898, 1905, and 1902 may be taken as examples of years showing fever prevalence of a generally distributed character, but at the same time they are years of marked contrast in regard to the extent of prevalence and the forms of fever prevailing.

In 1898 very high fever prevalence was observed, the ratio for *all* continued fevers, 239·6 per 1000, being the highest recorded since 1859, but the excessive prevalence was chiefly in cases of simple continued fever, the admission rate for Mediterranean Fever being below the average for the nine years' period. The year which comes next in regard to high fever prevalence was 1905, with a total ratio of 229·6 per 1000, but in this year the ratio of 77·5 for Mediterranean Fever is the highest on record; the ratio for the simple continued fever cases was just above the average, as was also the admission rate for enteric fever. In 1902, although there was a large garrison, fever prevalence was at the lowest point observed in the nine years under

consideration, the Mediterranean Fever rate being the very low one of 17·7 per 1000, while the admission rates for both simple continued and enteric fevers were also below the average.

The years 1899, 1903, and 1904 present good examples of localised epidemic prevalence of Mediterranean Fever. The outbreak in the Essex Regiment in 1904 has been very fully described by Dr. Johnstone in Part II of these Reports. The outbreaks in 1899 and 1903 present points of epidemiological interest which seem worth putting on record.

In 1899, a sharp outbreak of Mediterranean and enteric fevers occurred amongst the civil population of Rabato, a suburb of Citta Vecchia, and about three-quarters of a mile distant from Imtarfa Barracks. At the same time both diseases made their appearance amongst the troops at Imtarfa, most of the cases being Mediterranean Fever. The epidemic lasted three months, May to July. The civil and military authorities joined hands in an endeavour to trace the source of the disease, without result. The points of interest are: (1) The sudden onset of the outbreak; (2) the simultaneous invasion of both military and civil sections of the population; (3) the time of year, which was rather early for an outbreak, as Mediterranean Fever is usually most prevalent from June to September, and the last six months of the year is the period of seasonal prevalence for enteric. The simultaneous invasion indicates a common factor, or factors. The barracks are situated in an isolated position, on a hill at some distance from Rabato. There was no reason to suspect the water supply, as no local source of pollution could be discovered, and it was common to other places which were not attacked. The barracks were only opened in 1896, and their sanitary condition should, therefore, have been satisfactory, and we are told that nothing was discovered to which the cause of the outbreak could be attributed. The only food supply common to both civil and military was milk, and although we are not in a position to give a definite negative to all other probabilities, viewed in the light of our present knowledge, milk as the causative factor seems best to explain epidemic prevalence, sudden onset, simultaneous invasion, and early appearance. We know that Rabato is a place having many herds of goats, and that, in recent times, goats there have yielded infected milk, and, by inference, therefore, possibly also in 1899. We know that milk from the goat often contains the *Micrococcus melitensis* in enormous numbers, but that the quantities present in the milk show great variations from time to time, that they may disappear for days and reappear later, and that no obvious relation has been observed to temperature or to season of the year, either in regard to abnormal presence of *Micrococcus melitensis*, or to their disappearance altogether from an infected milk.

In 1903, a very large outbreak occurred in the 1st Battalion

King's Royal Rifles. The regiment arrived in Malta from South Africa on October 16, 1902, and were quartered in Floriana barracks until the end of April, 1904, when they moved to Imtarfa barracks, where they remained until they left for Egypt on February 27, 1905. Major Glenn Allen, R.A.M.C., who was in charge of Floriana District at the time of the outbreak, states,* that the battalion contained a fair proportion of seasoned men on its first arrival, but during the first winter its strength was increased, and the places of old soldiers sent home, time expired, were filled by the arrival of two or three drafts from the depôt. So that by the time the warm weather began there were a good many young soldiers in the ranks who, by reason of their immaturity, may reasonably have been considered as specially liable to infection.

The following table gives a complete view of the fever prevalence during the entire time of the stay of the battalion in Malta:—

Month.	Mediterranean Fever.	Simple continued fever.	Enteric fever.
1902—			
October	—	2	—
November	—	2	1
December	—	1	1
1903—			
January	3	1	—
February	—	1	—
March	3	2	—
April	—	1	—
May	—	1	—
June	5	13	—
July	13	83	—
August	47	71	—
September	61	33	1
October	45	9	—
November	19	3	—
December	13	—	—
1904—			
January	7	1	—
February	1	—	—
March	5	—	—
April	2	—	—
May	7	—	—
June	4	2	1
July	4	3	—
August	3	—	1
September	4	—	1
October	—	—	1
November	1	—	—
December	1	—	1
1905—			
January	2	—	—
February	1	—	—

* 'Journal of the Royal Army Medical Corps' for June, 1904.

During 1903 there were in all 209 admissions for Mediterranean Fever, with five deaths, and 65 men had to be invalided. The special prevalence of the disease began in June, and the epidemic was at its height in August, September, and October. It will be observed from the monthly figures, given above, that the epidemic prevalence of Mediterranean Fever cases was preceded by epidemic prevalence of simple continued fevers, and that there had been admissions for simple continued fever from the very first month of the arrival of the battalion in Malta. It is interesting also to note the almost entire disappearance of simple continued fevers that marked the last 14 months of the stay of the regiment in Malta. In August and September, cases of Mediterranean Fever were also observed amongst the women and children of the regiment who were living in quite new married quarters, A Block, Misida Bastion. The enquiries made at the time of the outbreak appear to have been negative in their result, except that it was held that "insanitary conditions" would not explain its occurrence, and the tendency was to accept the theory of air-borne infection. Building operations were going on in the vicinity, and there had been much digging and turning over of the soil, but, as Major Glenn Allen points out, "By the time the fever made its appearance among the single men the new blocks of barracks were practically completed. The disturbance of the soil, involved in digging the foundations, had taken place during the time that another battalion was stationed in the Floriana District, among whom no exceptional number of cases had occurred." Nor was there any special prevalence of these fevers in the old married quarters, which are between the new blocks and the buildings occupied by the troops in Old Floriana barracks. As no conveniences are usually provided for the Maltese workmen employed on new buildings, the theory has recently been advanced that the soil becomes extensively polluted, and that the presence of one or more ambulatory cases among the workmen might be sufficient to sow the seeds of the disease. It has to be remembered, however, that infected urine does not usually contain the specific micrococci in large numbers, consequently very gross contamination of dust should not often occur. The fact also that the *Micrococcus melitensis* is readily destroyed by exposure to sunlight, and the rapid dilution that must occur when the dust is blowing about under natural conditions, are against dust being a very common factor. Dust-borne infection might be operative in causing a few cases, but, all things considered, it would not explain an epidemic, occurring in the hottest months of the year, and of the extent of the one under consideration. The only fresh fact we can give in connection with this outbreak is that the regimental milk supply was goats' milk. The supplier informed one of us this year (1906) that he and his forebears had supplied Floriana barracks with goats' milk for the last 20 years. In April, 1904, the battalion was

moved to Imtarfa, where there was no excessive prevalence of Mediterranean Fever, and several of the cases recorded as admissions were relapses from the previous year. After arrival in Egypt on March 4, 1905, the battalion was stationed at Cairo, where there were five admissions for Mediterranean Fever during that year. All of them were men who had been with the regiment in Malta, but only one of the five is known to have had fever there. The admissions were as follows:—

	Date of admission.	Date of discharge.	Interval since leaving Malta.
			days.
H. 5963 Private J.	9/5/05	9/10/05 (invalided)	70
H. 2573 Lance-Corporal J.* ...	8/8/05	25/9/05	161
H. 4736 Private H.	8/8/05	28/9/05	161
G. 2589 " L.	17/8/05	28/9/05	170
H. 4557 Boy S.	16/8/05	28/9/05	169

* Had Mediterranean Fever in Malta, 9/9/03—29/11/03.

The diagnosis in all five cases was confirmed by serum reaction. The interval between leaving Malta and the onset of illness is a long one in each case, and suggests fresh infection, but no men who had not been in Malta were attacked. The grouping of the cases, four men belonging to one company, and the closeness of the dates of the August admissions, suggest contact as a factor, especially as the second of the cases had had Malta fever previously, but the case for contact would have been better, had some man or men been attacked who had not been in Malta. It is also an open question as to whether the lance-corporal's case should be regarded as a relapse, after an interval of just over two years, or as a fresh infection. The milk supply of the battalion in Cairo was tinned milk, but the men might have had access to goats' milk outside barracks.

With reference to the epidemic and the prevalence of fevers generally in the battalion while in Malta, the epidemiological points which are of special interest are:—

(1) A large epidemic which was at its height from August to October. In 1899, epidemic prevalence occurred at Imtarfa during the three months May to July. This appears to indicate a factor outside seasonal prevalence.

(2) The epidemic prevalence of simple continued fevers, which preceded, and was associated with, the Mediterranean Fever outbreak.

(3) The remarkable absence of simple continued fevers which marked the hot weather of 1904, and which may have been the result

of the move of the regiment from the old barracks at Floriana to the new barracks at Imtarfa.

Prevalence in Barracks.—Floriana barracks are several times brought to notice for high fever prevalence during the period 1861 to 1897, but as to the exact character of the fever prevailing in such years no information is available. Simple continued fevers, no doubt, formed the bulk of the admissions, but simple continued fever is not as a rule a fatal disease, so that, as death rates were observed, the more severe types of fever, *i.e.*, Mediterranean and enteric, must also have been present. In the majority of the years of this period, Floriana does not rise above the average, and in some, notably 1864, 1865, 1867, and 1889, it is remarkable as having had a low fever prevalence. Since the years of separate fever statistics, Floriana occupied a prominent position, in regard to Mediterranean Fever prevalence, in 1897, and in 1903 there was a large epidemic; prevalence, rather above the average, was observed in 1904 and 1905, and considerably above the average in 1906; while 1898, 1899, and 1901 were years of very moderate prevalence; and 1900 and 1902 were years in which these barracks had a low prevalence of Mediterranean Fever.

Ricasoli, Verdala, Isola Gate, and Polverista barracks have each attracted special attention at different times, both for high and for low fever prevalence. Since 1897, Ricasoli has never shown more than low figures for Mediterranean Fever, although there were more cases than usual in 1905. Verdala barracks have maintained a fair reputation for moderate Mediterranean Fever prevalence in the years 1898 to 1906. Verdala has had at times a high admission rate for simple continued fevers, and it has had an enteric notoriety in the past.

Lower St. Elmo, which in 1859 was regarded as one of the most unhealthy barracks in Malta, was specially mentioned for low sickness rates in 1861, 1862, 1864, 1865, 1871, 1872, and 1889. In the Army Medical Department Report for 1872 it is stated that "Lower St. Elmo maintains its good character." But it occupied the highest place for fever prevalence in 1875 and again in 1883, while it had the second highest place in 1892. These barracks have had an enteric reputation in years past. As far as Mediterranean Fever is concerned, they have a fair repute from 1897 to 1903, but in both 1904 and 1905 they headed the list for Mediterranean Fever prevalence, while in 1898 and again in 1902 low prevalence was observed.

Manoel barracks have never shown more than moderate prevalence up to 1905, when each contributed about five times its average number of cases.

St. George's barracks, Pembroke, have usually shown moderate prevalence, but here, too, there was a considerable increase in 1905.

Even the newest, well built and well sited barracks are not exempt, as Imtarfa barracks, which are situated on a hill in the open country,

began to show fever prevalence in 1896, the year they were opened; a sharp outbreak of Mediterranean Fever occurred in them in 1899; and they again showed more than ordinary prevalence in 1905. Tigne (stone barracks), opened in 1901, the new blocks at Floriana, opened in 1903, and St. Andrews barracks, opened in May, 1905, have all contributed cases of Mediterranean Fever. The same is true of both old and new married quarters. The provision of new buildings with sanitary fittings and general surroundings far in advance of those of remote periods has not prevented the occurrence of Mediterranean Fever amongst the occupants.

The foregoing considerations show that great irregularity is manifested from year to year in regard to the extent of fever prevalence in the various barracks in Malta. There is no evidence of a persistent and constantly recurring place infection in connection with any of the barracks, except perhaps in Floriana old barracks, which, since the large epidemic of 1903, appears to have contributed more than its normal share of cases of Mediterranean Fever in 1904 and 1906, but it was better than Lower St. Elmo in 1905.

3. *Prevalence of Mediterranean Fever in Different Branches of the Service.*

The following table shows the prevalence of Mediterranean Fever in Malta, by branches of the service, during the four years 1902 to 1905.

(1) *Artillery and Infantry Compared.*—This table shows that the artillery have suffered less from Mediterranean Fever than the infantry, the ratio for the former being 28·0 against 47·2 per 1000 for the latter. The general sickness rate amongst artillery is generally better than the infantry, but this, it is thought, would be insufficient to account for the large difference in prevalence of Mediterranean Fever. One very important difference between the two bodies of men is that the artillery generally have used condensed milk, while the infantry have used goats' milk. We are not absolutely certain about the milk supply of some of the artillery units that left Malta during the early part of the four years' period, but on the assumption that they used goats' milk in place of condensed milk, it would only make the difference in the rates the more striking.

(2) *Special Prevalence of Mediterranean Fever in the Royal Army Medical Corps.*—This is obviously an important point, more particularly as a similar special liability is observed among the Sick Berth Staff of the naval hospital at Bighi.

Table V, p. 151, shows that during the four years 1902 to 1905 the incidence rate for the Royal Army Medical Corps is three times the infantry rate, 148 as compared with 47·2 per 1000. The general

Table V.

	1902—05, aggregate strength.	Mediterranean Fever.		Simple continued fever.		Enteric fever.		Total continued fevers.	
		Admissions.	Ratio per 1000.	Admissions.	Ratio per 1000.	Admissions.	Ratio per 1000.	Admissions.	Ratio per 1000.
Royal Garrison Artillery	7,571	212	28·0	649	85·7	25	3·0	886	116·7
Infantry (excluding Crete)	24,801	1,171	47·2	3,427	138·1	163	6·6	4,761	191·9
Royal Engineers	1,311	29	22·1	69	52·6	6	4·6	104	79·3
Army Service Corps	199†	12	60·3	18	90·4	1	5·0	31	155·7
Royal Army Medical Corps	527	78	148·0	113	214·4	3	5·7	194	368·1
Army Ordnance Corps ...	262	10	38·2	20	76·4	—	—	30	114·6
Garrison Staff	254	9	35·4	13	51·2	—	—	22	86·6
Militia*	250	1	4·0	2	8·0	1	4·0	4	16·0
	35,175	1,522	43·2	4,811	122·5	199	5·7	6,032	171·4

* 1902 only. † 3 years only, 1903—05.

admission rate from all causes for the Royal Army Medical Corps usually conforms fairly closely to that of the infantry, but, in that year of special fever prevalence, 1905, the medical unit had a general admission ratio of 974·2 per 1000 against 681·8 for the infantry. It is also observed that continued fevers, using the designation in its inclusive sense, caused 50 per cent. of the total admissions to hospital from all causes among the Royal Army Medical Corps, whereas in the garrison as a whole the proportion is about 21 per cent., and even that must be regarded as an excessive proportion.

From the beginning of 1902 up to the end of September, 1906, the average annual strengths of the Royal Army Medical Corps were 99 in 1902, 140 in 1903, 143 in 1904, 155 in 1905, and 164 for January to September, 1906. The actual number of non-commissioned officers and men who served in Malta during the period in question is 364, and of these three were there for the second time. Of the 364 men, 92 contracted Mediterranean Fever, their service in Malta at the time of contraction being:—

Under 1 year.	1 to 2 years.	2 to 3 years.	3 to 4 years.	4 to 5 years.	5 to 10 years.	Total.
44	24	14	6	2	2	92

These figures demonstrate the special liability of the newcomer to attack by Mediterranean Fever.

Including simple continued and enteric fevers with Mediterranean Fever, an examination of the corps records in Malta showed that a considerable proportion of men escape fever altogether, and employments which figure often in this group were wardmasters, compounders, clerks and men employed in stores.

The following table gives the admissions for continued fevers during the four years 1902 to 1905. Of the 92 cases referred to above, five were men who had contracted the disease prior to 1902, and there were nine re-admissions, hence the total of 78 admissions for Mediterranean Fever shown in the table.

Royal Army Medical Corps.

Year.	Average annual strength.	Mediterranean Fever. Admissions.	Mediterranean Fever. Ratios per 1000.	Simple continued fever. Admissions.	Simple continued fever. Ratios per 1000.	Enteric fever. Admissions.	Enteric fever. Ratios per 1000.	Total continued fevers. Admissions.	Total continued fevers. Ratios per 1000.
1902	99	3	30·3	16	161·6	1	10·1	20	202·0
1903	140	17	121·4	27	192·9	—	—	44	314·3
1904	143	19	132·9	27	188·8	1	7·0	47	328·7
1905	155	39	251·6	43	277·4	1	6·4	83	535·4
		78	148·0	113	214·4	3	5·7	194	368·1

During these four years 50 men of the Royal Army Medical Corps were invalided on account of Mediterranean Fever, and it caused two deaths, both in 1905.

Next to the great prevalence of fevers in 1905, the marked disparity between 1902 and the following years, as regards fever prevalence, is the point which shows up most prominently in this table. The most probable explanation of this is absence of the usual arrival of susceptible material, owing to the fewness of reliefs during the South African War years, 1899 to 1902. That there were very few fresh arrivals to join the corps at this period is well shown in the following analysis of the composition of the Royal Army Medical Corps unit serving in Malta at the beginning of 1902. It was composed of men who had joined as under :—

1895.	1897.	1898.	1899.	1900.	1901.
1	19	53	9	3	10

In 1902, 77 men joined the station, six of them between February and August, 70 on October 14, and one in November. With the accession of this fresh material, Mediterranean Fever began after a brief interval. There were only three admissions for the disease in 1902. The first was a man who had joined in January, 1901, and who was admitted on January 24, 1902. The next was the case of a man who, within a month of his arrival on May 21, 1902, was admitted for simple continued fever, and was almost continuously ill afterwards, until invalided on March 10, 1903; no blood reaction was obtained in this case until October 8, 1902. The third was a man of the large draft which arrived on October 14, who was admitted for Mediterranean Fever on December 19. The subsequent history of

this draft is as follows: eight of the men were admitted for the disease in 1903, eight more in 1904, four in 1905, and three in 1906, 24 cases in all out of 70 men.

The distribution of the disease in the detachments serving in the various military hospitals during the four years was as follows:—

Hospitals.

	Valletta.	Cottonera.	Forrest.	Civita Vecchia.	Imtarfa.	Gozo.
1902	3 (60)	— (52)	— (12)	— (15)	— (13)	— (3)
1903	4 (222)	8 (66)	— (32)	1 (70)	— (14)	— (0)
1904	10 (167)	6 (62)	1 (27)	1 (22)	— (28)	— (14)
1905	20 (300)	9 (143)	2 (93)	3 (32)	1 (69)	— (6)
Total	37 (749)	23 (323)	3 (164)	5 (139)	1 (124)	— (23)
Admissions, ratio per 1000 of corps strength, 1902—05	154·1	149·3	76·9	98·0	32·2	—

The figures within the brackets indicate the number of cases of Mediterranean Fever admitted during the year to each hospital. Cases were treated in each of these hospitals up to May, 1906, after which all cases of the disease were sent to Valletta. This table shows that there is no constant relation between the numbers of cases occurring among the sick attendants and the quantity of possibly infective material in the wards. For example, at Valletta in 1903 there were four Royal Army Medical Corps cases with 222 admissions for the disease, while in 1905 there were 20 cases in a year which had 300 admissions. At Cottonera in 1903 there were eight corps cases with 66 Mediterranean Fever cases, while in 1905 there were only nine when more than double the 1903 number of cases passed through the hospital. Compare also Civita Vecchia, one with 70 in 1903, and three in 1905, when there were but 32 admissions.

The monthly distribution of cases was as under:—

Royal Army Medical Corps.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1902	1	—	—	—	—	—	—	—	—	1	—	1
1903	1	—	1	1	2	2	1	2	1	1	2	3
1904	1	4	1	—	1	1	2	3	—	2	2	2
1905	3	—	1	2	3	4	8	10	2	2	1	3
1906	3	3	1	3	5	1	—	2	—	—	—	—

The monthly prevalence of the disease in the corps follows very much the same distribution as is exhibited by the rest of the garrison.

Occupation.—The duties of the 69 men at the time they contracted the disease were as follows:—

1902—03.	Men.	1904—05.	Men.	Total.
Ward duty	9	Ward duty { Nurses	19	45
		Ward duty { General duty	17	
Cooking class	8	Cooking class	5	12
Cooks	—	Cooks	4	
Stewards' stores	2	Clerks	3	
Compounder	1	District staff	2	
Steward	1	Day ward master and stewards' stores	1	
		Pack and linen store	1	
		Steward	1	
Total	16	Total	53	

Ward Duty.—Prior to 1904, all the men of the Royal Army Medical Corps employed on "ward duty" took more or less share in nursing the sick, but since 1904 these men have been divided into two classes, namely, a nursing section, the men belonging to which are specially charged with the nursing of the sick, and a general duty section, to the men of which falls the cleaning work of the wards. The nursing section man, therefore, comes into more intimate contact with patients than the general duty man; but the latter, in times of special strain, may sometimes have to lend a hand in nursing, and often men belonging to the general duty section are working as probationers, with a view to passing into the nursing section. The general duty man employed in and about the Mediterranean Fever wards must necessarily handle possibly infected clothing and bedding, and may also come in contact with infected urine in latrine work.

The evidence which tells most in support of contact as a factor in the causation of the special prevalence of the disease amongst the men of the corps in Malta is that given by Kennedy,* in which he shows that while both nursing section and general duty men employed in 1905 in 20A ward, Valletta Hospital, the ward in which Mediterranean Fever cases were treated, contracted the disease, yet no attacks occurred amongst the men of either class who were employed in other wards, where there were no such cases. There are, however, some stumbling blocks in the way of general acceptance of the view that contact with cases is a factor of primary importance. There would appear to be no constant relation between the numbers of cases

* 'Journal of the Royal Army Medical Corps' for April, 1906.

occurring amongst the sick attendants and the quantity of infective material in the wards, and the history of previous years does not always show that men doing ward duty are marked out by special liability to attack. For instance, it is observed, on analysis of the cases that occurred in 1903 amongst the detachment at Cottonera, that the employments of the eight men who contracted the disease were as follows:—Compounder, 1; in the steward's stores, 2; cooking class, 3; and ward duty, 2; but one of the latter was employed in the itch tents, and the other was a lunatic attendant. Again, the nursing sisters do not show special liability to the disease in the performance of their nursing duties. There were six cases amongst the sisters at Cottonera in 1904 to 1905, but no cases of the disease have been observed amongst the nursing sisters at Valletta, although they have had to deal with more than double the number of cases of Mediterranean Fever during the four years under discussion. It is also important to note that contact with cases of the disease is not accompanied by the occurrence of cases among the sick attendants on the hospital ship "Maine" or in the home military and naval hospitals. No such cases have ever been observed, although there must be the same contact in nursing patients and the same handling of infected clothing, bedding, and excreta as in Malta, and probably with less attention to personal precautions than is observed in the case of the nursing staffs of the hospitals in Malta. These facts seem to completely negative the view that "contact" is a factor of primary importance in the causation of the special prevalence which has been observed among the men of the Royal Army Medical Corps in Malta. The one great difference in the conditions between nursing cases of the disease in Malta and away from Malta is the complete absence of a specifically infected milk supply in the latter case, and its common presence, at all events in the past, in the former.

Cooking.—The common occurrence of cases of the disease amongst men employed in cooking in military hospitals in Malta is a significant fact, and one in which infection by milk is strongly suggested, as these men had the handling of milk before its sterilisation. Cases of this kind seem to have been of particularly common occurrence at Cottonera in the past.

Superintendence of Goat Milking.—Three cases have been observed in which this formed part of the duties of the men attacked.

Handling Infective Material.—Three out of four men belonging to the Royal Army Medical Corps who have been employed in the Commission laboratory have been attacked by Mediterranean Fever, one in 1905 and two in 1906. In their case the probabilities are strongly in favour of the disease having been contracted by the handling of infective material. It is also possible that infection sometimes occurs from handling infected clothing, bedding, excreta, etc.

(3) *Interval between Arrival of Units in Malta and the First Appearance of Cases of Mediterranean Fever.*

Table VI.

Units.	Date of arrival in Malta.	From—	First cases of— Simple continued fever.	First cases of— Mediterranean Fever.	First cases of— Enteric fever.	Interval between arrival in Malta and appearance of Mediterranean Fever.
1st Royal West Kent Regiment	24/2/02	Aden	April	April	June	6 weeks
2nd Cameron Highlanders.............	4/5/02	S. Africa	June	August	September	3 months
2nd K.O. Yorkshire Light Infantry...	28/10/02	England	December	January, 1903	November	2 „
1st King's Royal Rifles	16/10/02	S. Africa	October	„	„	2½ „
1st Royal Dublin Fusiliers	23/11/02	„	December	December	December	2 weeks
2nd Hampshire Regiment	17/9/03	Gibraltar	September.	November	November	6 „
1st Royal West Kent Regiment*	15/4/04	England	May	July	June	2½ months
1st Rifle Brigade	20/4/04	„	„	June	July	6 weeks
2nd Essex Regiment	28/4/04	„	June	„	May	5 „
2nd Royal Sussex Regiment	27/6/04	„	„	July	August	4 „
1st Lancashire Fusiliers	27/2/05	Gibraltar	April	April	July	1 month
4th Rifle Brigade.........................	16/11/05	England	February, 1906	April, 1905	—	4½ months
4th Worcestershire Regiment	2/12/05	Barbados	January, 1906	February, 1905	March, 1906	2 „
Royal Garrison Artillery—						
No. 77 Company	11/3/02	Gibraltar	April	May	May	2 months
81 „	16/10/02	„	October	August, 1903	—	8½ „
93 „	9/10/02	„	„	November	December	1 month
96 „	9/10/02	„	November	March, 1903	—	4½ months
63 „	16/10/02	S. Africa	October	December	January, 1903	1½ „
92 „	16/10/02	„	December	November	December	3 weeks
99 „	17/11/03	Gibraltar	„	March, 1905	August, 1904	15½ months
100 „	17/11/03	„	November	December	July, 1904	3 weeks
102 „	29/9/04	„	„	May, 1905	December, 1904	7 months
65 „	4/11/04	India	„	February, 1905	November, 1904	3 „
1 „	12/11/04	Gibraltar	December	December	January, 1906	1 month
5 „	12/11/04	„	May, 1905	June, 1905	July, 1905	6½ months

* Second Period of Service in Malta.

It is very significant that since the milk change, that is to say, during the last six months of 1906, there have been but two cases, both at Valletta, and both inoculated men. One was a laboratory attendant and the other is a possible relapse. (See Cases 17 and 18, Series II, the cases in the Royal Army Medical Corps, p. 194, where the cases occurring in 1906 are discussed in detail.)

The foregoing table indicates :—

1. That no unit escapes attack by Mediterranean Fever.

2. That an interval always elapses between the arrival of a unit in Malta and the first appearance of Mediterranean Fever. That is to say, the sufferers have to come to Malta to contract the disease, they are not landed suffering from it.

3. That, in the infantry, the interval has varied from under 3 weeks to, in one instance only, 4½ months (units whose milk supply is usually goats' milk).

4. That, in the artillery, the interval is often much lengthened, varying from 3 weeks to 4½, 5½, 7, 8½, and 15½ months (units whose milk supply is condensed milk). It will be observed that many of the artillery companies are moved on from Gibraltar to Malta, and it might be urged that the susceptible men have been exhausted during the service of the company in the former station, but exhaustion of material will not explain the point, as there has been very little Mediterranean Fever amongst the troops in Gibraltar during the years in question.

5. That simple continued fevers nearly always appear first, and that enteric fever is generally later in showing itself than either Mediterranean or simple continued fevers.

(4) *Prevalence amongst Officers, Women, and Children.*—Table VII gives the Mediterranean Fever statistics relating to officers, women, and children for the nine years 1897 to 1905. The figures for the N.C.O.'s and men are added, to give a complete view of the prevalence of this fever in the garrison throughout the period in which separate statistics become available.

It has been divided into separate periods, because during the second period the serum reaction, as an aid to diagnosis, was in routine use throughout, but this was not the case in the first four years, 1897 to 1900. Blood examinations in cases suspected to be Mediterranean Fever were carried out by individual medical officers from about 1899, but an order was published on November 6, 1900, directing that these examinations were to be made in all cases. The figures relating to the second period are, therefore, the more complete, and that is why the following remarks are confined to that period.

On making an analysis of the statistics relating to the garrison as a whole, it was found that, in proportion to strength, the liability of the officer to be attacked by Mediterranean Fever is over three times as

(*To face p.* 158.)

Children.			Totals.				
	Ratios per 1000.					Ratios per 1000.	
Deaths.	Admissions.	Deaths.	Average strength.	Admissions.	Deaths.	Admissions.	Deaths.
1	8·1	1·35	9,454	309	15	32·7	1·58
—	21·1	—	8,855	254	10	28·7	1·13
—	7·9	—	8,907	330	11	37·0	1·23
—	4·2	—	9,516	188	11	19·8	1·16
	10·5	0·34				29·4	1·28
—	11·0	—	9,725	313	11	32·2	1·13
—	16·0	—	10,683	224	10	21·0	0·94
1	27·3	0·83	10,984	561	11	51·1	1·00
—	42·0	—	10,860	454	19	41·8	1·75
—	17·4	—	9,919	750	17	75·6	1·71
	23·1	0·20				44·1	1·30
2	18·4	0·25	—	3383	115	38·0	1·29

great as in the case of the man. Soldiers' wives are attacked in about the proportion of two to one as compared with the men. Children are the least liable of all to attack. The figures are as follows:—

Admission Ratios, 1901 to 1905.

Officers	131·5 per 1000 of strength.		
Soldiers' wives	88·2	„	„
N.C.O.'s and men ...	41·1	„	„
Children	23·1	„	„

Another very striking fact is the high mortality rate observed amongst soldiers' wives. The percentages of deaths to attacks are as under:—

Percentages of Mortality to Attack, 1901—1905.

Soldiers' wives	5	per cent.
N.C O.'s and men.........	2·8	„
Officers	1·7	„
Children	0·87	„

The special liability of the officer to attack is not readily explainable on a general assumption that the occurrence of the disease is usually associated with insanitary conditions. At least as much care is bestowed on the maintenance of officers' quarters and messes in a satisfactory sanitary state as is given to keeping barracks in a sound condition. He is also as a rule less exposed to possible mosquito bites than the man, as many officers use mosquito nets, whereas the men are seldom or never protected in that way. Nor can the officer be said to be more exposed to the possibility of infection by infected dust. Yet the fact remains that he is three times more liable to attack by Mediterranean Fever than the man. The milk hypothesis seems best to explain this greater liability. The officer more often eats foods with milk or prepared with milk, at messes, at clubs, or at the houses of his friends. Very likely, too, in the past, he often got unsterilised goats' milk with tea or coffee, etc., and infection may sometimes have been conveyed in cream or milk with fruits or jellies, ices, etc. Bearing in mind the extent to which the goats' milk supply of Malta contains the *Micrococcus melitensis*, if it be granted that the officer is more in the habit of consuming milk in various forms, it must equally be acknowledged that he is to a corresponding extent more exposed than the soldier to chances of partaking infected milk.

The same reasoning, only in lesser degree, may also afford an explanation of the greater liability to attack exhibited by soldiers' wives. It may also be pointed out in this connection that Table VII, facing p. 158, shows that both women and children had unusually high attack rates in 1903 and 1904, which were the years just before the dangers attending the consumption of unsterilised goats' milk were

known, while in 1905, notwithstanding that there was much Mediterranean Fever about, the incidence rate for both women and children is much lower than in the two preceding years, a circumstance which may be due to attention to instructions which were issued in that year enjoining the sterilisation of goats' milk by boiling.

With regard to the high percentage mortality to attack in the case of soldiers' wives, possible explanations may be that the women often attempt to carry on their household work too long, and only give in when they become very ill, handicapping in this way their chances of recovery, and it is also probable that all the cases do not come under observation.

(5) *Age and Service in Malta in Relation to Mediterranean Fever.*—The following tables show the relation of age and length of service to admissions, deaths and invaliding on account of Mediterranean Fever during the four years 1902 to 1905.

Table VIII.—Age in Relation to Mediterranean Fever, 1902 to 1905.

Age.	1902–05. Aggregate strength.	Admissions.	Deaths.	Invalids sent home.	Ratios per 1000.		
					Admissions.	Deaths.	Invaliding.
Under 20 yrs.	4,827	190	4	101	39·3	0·82	20·9
20 to 25 ,,	14,774	811	13	352	54·9	0·88	23·8
25 ,, 30 ,,	7,423	233	7	96	31·3	0·94	12·9
30 ,, 35 ,,	4,205	125	9	49	29·7	2·14	11·6
35 ,, 40 ,,	3,871	120	5	38	31·0	1·29	9·8
40 years and over	845	43	3	16	50·9	3·55	18·7
	35,945	1522	41	652	42·3	1·14	18·1

It will be observed that men from 20 to 25 years of age appear to be more liable to attack than men from 25 to 40, and that increased liability is again manifested by men over 40 years of age. The mortality is, however, markedly less for men under 30 than it is for men over that age. Men under 25 show a larger proportion of invalids than the older men, but invaliding again shows increase for men over 40, a group which has also the highest death rate. The tables for the separate years will be found in the corresponding annual A.M.D. Reports, and tables for 1902 and 1903 were given by Dr. Johnstone in Part II of the Commission Reports. On making a comparison of the statistics for 1902 with those for other years, it is observed that the garrison in 1902 contained a larger proportion of older men than usual. For instance, comparing 1902, a year of light fever prevalence, with 1905, the year presenting the heaviest known incidence of Mediterranean Fever, the figures are as follows:—

Year	1902.	1905.
Age groups.	Average strength (8758).	Average strength (8294).
From 30 to 35 years	1498	609
„ 35 „ 40 „	1593	242
„ 40 years and over	230	72

In 1902, also, there would be a more stable garrison, as owing to the South African War there would be less movement of men through incoming and outgoing troops, and therefore a proportionate lessening of susceptible material. It is of interest to note that the war years, 1900 to 1902, all showed moderate fever prevalence, taking Mediterranean, enteric, and simple continued fevers into account, and this was specially the case in regard to 1900 and 1902. The same moderate general fever prevalence was observed in 1903, although there was in that year a considerable increase in the prevalence of Mediterranean Fever. In connection with these years, also, it must be pointed out that the 1st, 3rd, and 4th Royal Garrison Regiments formed part of the Malta Garrison from the end of 1901 to April, 1904, and that these regiments were largely composed of old soldiers. The garrison regiments had a very moderate fever incidence throughout their stay in Malta, less than is usually observed in the regular infantry regiment. Coincident with return to ordinary peace conditions, increased fever prevalence made its appearance in 1904, reaching a climax in 1905.

Table IX.—Service in Malta in Relation to Mediterranean Fever, 1902 to 1905.

Service in Malta.	1902–05. Aggregate strength.	Admissions.	Deaths.	Invalids sent home.	Ratios per 1000.		
					Admissions.	Deaths.	Invaliding.
Under 1 yr.	17,820	839	14	315	47·0	0·78	17·7
1 to 2 yrs.	11,356	454	12	231	39·9	1·05	20·3
2 „ 3 „	4,016	140	8	58	34·8	1·99	14·4
3 „ 4 „	1,197	41	4	19	34·2	3·34	15·9
4 „ 5 „	712	14	—	7	19·6	—	9·8
5 „ 10 „	657	32	2	22	48·7	3·04	33·5
10 years and over	187	2	1	—	10·7	5·34	—
	35,945	1522	41	652	42·3	1·14	18·1

Fifty-five per cent. of the cases of Mediterranean Fever in these four years occurred amongst men of under one year's service in Malta, and 30 per cent. were men in their second year of service there, so that 85 per cent. of the admissions occurred amongst men who had been under two years in the garrison, and the invaliding bore almost the same proportion. Mortality is, however, much more marked in connection with cases occurring after the second year of service in Malta. This is shown by the figures in Table IX, but it is even better shown in the 1905 table, from which the following figures are taken. They represent 16 deaths amongst 643 admissions.

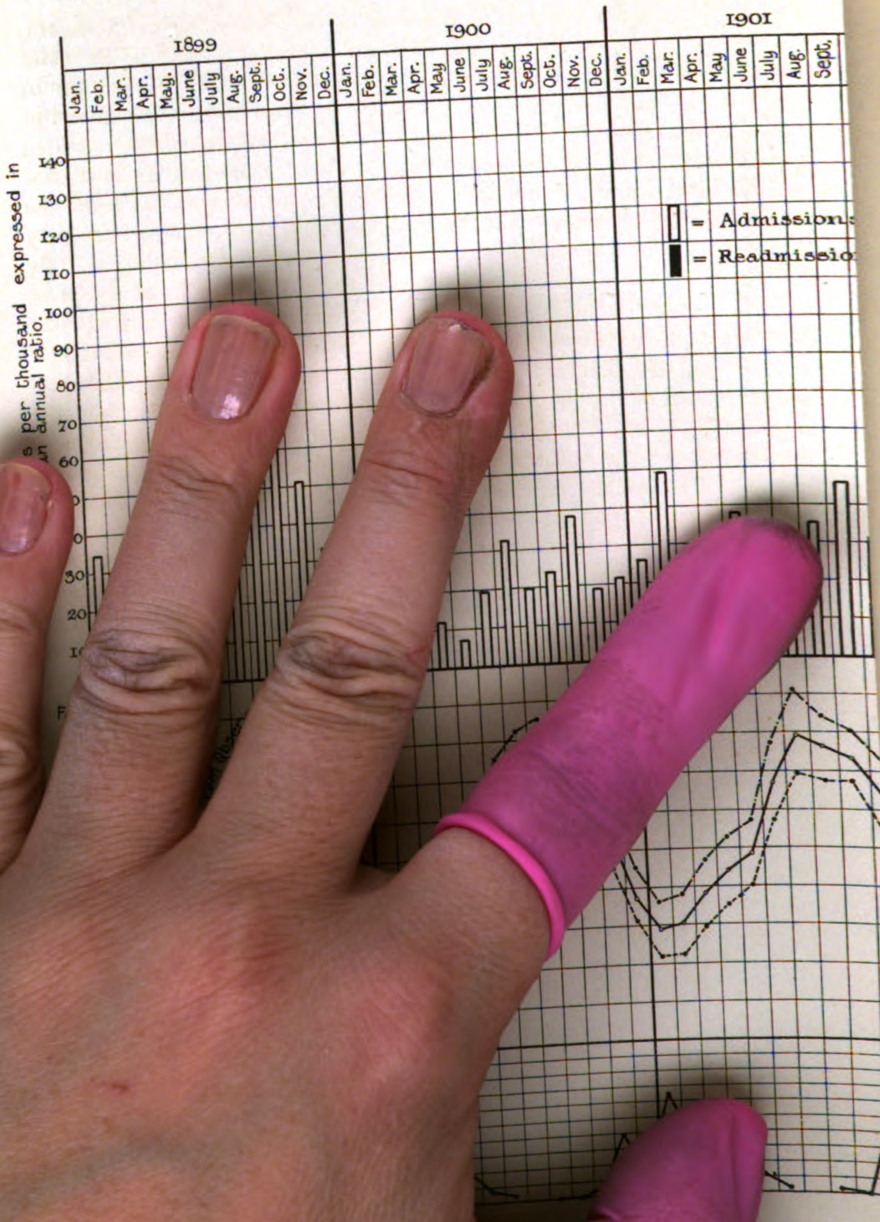
1905.	Death rate per 1000 of strength.
Under 1 year............	1·41
1 to 2 years	1·66
2 „ 3 „	3·15
3 „ 4 „	9·26

This would appear to indicate either that after the second year men are less able to resist the inroads of disease, or that invaliding saves a proportion of the cases belonging to the earlier periods.

In connection with deaths from Mediterranean Fever, it may be mentioned that army medical officers in Malta have observed that fever cases do badly in a season when "Sirocco" is a marked feature. The Cottonera Hospital annual return for 1897 contains the following remarks on this point:—"It was also noted what an influence sirocco winds had on the course of fevers. This is a very damp and a very depressing south-east wind, and with it came high temperatures (patients), great depression and often death."

(6) *Climate in Relation to the Prevalence of Mediterranean Fever.*—In Chart 4 the relation of temperature and rainfall to the incidence of Mediterranean Fever is shown for the years 1899 to 1906 month by month, and in Chart 5, p. 220, general curves for the period 1899 to 1905 are given. The curves in the latter chart appear to show a definite relation between temperature and case incidence, the rise of temperature preceding the increase of incidence, while the rise of the rainfall curve coincides almost in point of time with the beginning of the decline in case prevalence. If, however, the temperature and rainfall curves for the separate years are examined (*vide* Chart 4) in relation to the case incidence of the particular year, it is impossible to make out any constant relation of the kind indicated by the combined curves for the series of years. It is not even constantly true that the greatest incidence corresponds to the hottest season of the year, as, for example, it did not in 1902. Again, the climatic conditions of heat and drought are associated with a small prevalence of Mediterranean Fever in 1902, but with very great prevalence of the disease in 1905. Further, in

(To face p. 163.)



Chart

1902, the largest number of cases occurred during the rainy season, following a period of prolonged (four months) drought, the chief prevalence being in September, October, and November, whereas in 1905 the chief prevalence was in the dry months, March to the end of September. In 1905 Mediterranean Fever reached its highest recorded prevalence. The rise began in February, shot up suddenly in May, and reached its summit in September. During this period, *i.e.*, from the beginning of February to the end of September, there was only 4·356 inches of rain out of a total for the year of 25·103 inches. By far the greatest rainfall occurred in the three last months of the year, October (3·672 inches), November (1·699 inches), and December (9·591 inches), and coincidently there was a large decrease of fever prevalence. It is observed, however, that decrease of a marked character had commenced before the occurrence of any heavy rainfall, and that the decline in prevalence continued very markedly during November, a month when little rain fell, and before the occurrence of the excessive rainfall of December. A possible explanation of such irregularities may be found in the presence or absence of an accumulation of susceptible individuals. There must be constant variation in the quantity of susceptible material in the garrison, owing to the frequent changes of the individuals forming a military population and, as already stated on p. 161, we have reason to think that absence of an accumulation of susceptible individuals marked the year 1902. It should also be remembered that the numbers of *Micrococcus melitensis* excreted in the milk of the goat are liable to great variations, which appear to have no definite relation to season of the year.

For the garrison, the period of seasonal prevalence would appear to be from May to October (*vide* Chart 5, p. 220), prevalence being at its height in August and September, while the chart also shows that the disease is present throughout the year, and that there is nothing much to pick and choose between the five months December to April, as far as moderate prevalence is concerned, at least that is the case for the period 1899—1905.

Section II.—Mediterranean Fever in the Garrison in 1906.

During the first four months of 1906 the strength of the garrison was, roughly speaking, about 8000 men. The 1st Battalion Lancashire Fusiliers left for Egypt on April 30, and they were followed there by the 4th Battalion Worcestershire Regiment on May 8, the strength in May being reduced, by the departure of these two regiments and by the departure of a detachment of the 2nd Royal Sussex Regiment for Crete, to just under 6000 men. The Worcestershire Regiment returned to Malta on June 12, and from that time up to the end of September the strength was between 6500 and 6800 men. The 1st Battalion

the Rifle Brigade left for England in October. The 1st Battalion Lancashire Fusiliers returned to Malta from Egypt on December 17, and the 1st Battalion Royal West Kent Regiment left for England on the following day.

By the departure of the Lancashire Fusiliers in April, Lower St. Elmo barracks and the Manoel hutments were cleared, but shortly afterwards a detachment of artillery was quartered in Lower St. Elmo, to relieve a somewhat congested state of the barracks at Upper St. Elmo and St. James Cavalier. Old Floriana barracks were vacated on July 11, the men of the 1st Battalion Royal West Kent Regiment, who occupied them, being moved to the Manoel hutments, partly because Old Floriana barracks have long been regarded as among the most unsatisfactory in Malta from a health point of view, and partly because there was a persistence of fever cases. All the old barracks in Cottonera Lines, which were closed in 1905, have remained closed. The small rooms in Tigne Fort still continue to be occupied, although they are most undesirable as quarters, owing to bad ventilation, especially of the lower rooms. Lieut.-Colonel Davies stated in last year's report that he had been informed that they were to be evacuated shortly. St. Francis Barracks, Floriana, were overcrowded at the time cases of Mediterranean Fever were occurring in them towards the end of May. The beds were very close together. The rooms are very high, but the question is one of giving sufficient floor space, and each man should have at least 60 square feet superficial area, and no height over 12 feet should be used in estimating the cubic space per head of a barrack room. The barrack accommodation at Valletta Hospital is insufficient for the needs of the detachment of the Royal Army Medical Corps, and a small ward had to be taken into use as an additional barrack room. With the exceptions mentioned, there was no overcrowding and, in fact, the troops were quartered under more satisfactory conditions than appears to have been the case in previous years.

There is no necessity for us to enter upon a detailed discussion of the sanitary conditions of the various barracks, as they were fully gone into last year. We made a preliminary sanitary survey of the barracks and camps, in order to make ourselves acquainted with the conditions prevailing, and we were constantly in and out of barracks in the course of investigation of cases. We are accordingly in a position to state that there was much sanitary activity in evidence, both on the part of the medical and the regimental authorities, and that the barracks generally were maintained in a satisfactory condition. It stands to the credit of Malta, that it is one of the first garrisons in which the infantry units adopted the plan of having a permanent sanitary staff under the orders of the quartermaster of the regiment. This scheme, which was commenced in the beginning of June, has worked very satisfactorily, and has in no instance hampered in any way regimental

administration or training, while it has much facilitated the task of maintaining barracks in a satisfactory sanitary state.

The water supply remains as described in previous reports. *Micrococcus melitensis* has never been found in it under natural conditions. We have no evidence which indicates it as a possible vehicle of the disease and, indeed, the scattered distribution of the cases of Mediterranean Fever in barracks, which, as in former years, was also the rule in 1906, is against water-borne infection.

1. *Drainage, Barrack Supplies, &c.*

Drainage.—There are two important changes for the better to report: one in connection with barracks, and the other affecting the drainage system of Valletta and the three cities generally. Neither of them, however, bears any relation to the prevalence of Mediterranean Fever in 1906. The first relates to the conversion of the dry earth latrines at Imtarfa Barracks to a water carriage system, the work of reconstruction having been commenced in August. The second improvement was the flushing of the entire system of town sewers twice a day instead of once as heretofore. This change was made late in the season in August. We have obtained no evidence in the course of our enquiries which would connect drainage defects with the occurrence of any case or cases of the disease.

Barrack Supplies.—Bread and meat are the only parts of the soldier's ration which are supplied by the State. All supplementary food is provided under regimental arrangements. In Malta, the bread is baked in a military bakery by men belonging to the Army Service Corps. There is a military section at the public abbattoir, from which all the meat for the troops comes, the animals having been previously inspected by the civil veterinary officer, who is in charge of the abbattoir. The groceries are purchased from the regimental grocery bars, which almost universally obtain the chief part of their supplies from English sources. The regimental institutes, such as coffee bars, etc., are generally catered for by Maltese, and the supplies usually come from Maltese sources. The grocery bars may be dismissed as selling nothing likely to have any direct relation to the causation of Mediterranean Fever. The coffee shops in barracks cannot be so lightly dismissed, as milk is used in these places. Tea, coffee, cocoa, milk, aerated waters, various kinds of cooked foods, bread, cakes, fresh vegetables, fruits, etc., are supplied. Condensed milk is the form of milk in general use in the coffee shops, but in some instances, up to the time of the milk change being made, goats' milk was used. Even after that, we have evidence that it was possible to purchase goats' milk at coffee bars in barracks, but this was probably not a very common occurrence. However, the fact that it was possible to occur at all indicates that these places require careful supervision in this respect. Neither locally made butter nor cheese has ever

been observed in any of the coffee bars in barracks. The bread and cakes are usually from Maltese bakehouses, but we have no reason to suspect them of conveying disease, and the same is true of the aerated waters supplied. Tomatoes, spring onions, lettuce, radishes, cucumbers, grapes, apricots, apples, oranges, etc., can all be purchased at these bars in their season. Tomatoes and spring onions are in common use in some barracks, especially among the artillery and engineers, and are often taken uncooked with cheese for supper. These articles are sometimes eaten unwashed, and in one instance the man told us that the tomatoes he had been eating were gritty. The possibilities of these vegetables coming from heavily manured ground, or of their lying about on contaminated surfaces in Maltese houses and courtyards, before they are brought into barracks, which we have ourselves seen, must be borne in mind, as they may be potential sources of disease. Hawkers very often bring these articles into barracks for sale, and men also purchase them outside barracks.

Soldiers' Homes.—There are Church of England homes in Valletta and at Pembroke, Wesleyan homes in the Floriana and Cottonera districts, and a Roman Catholic home in the Floriana district. Tea, coffee, cocoa and other refreshments can be obtained, and the homes are usually well managed. We were informed that the milk used was condensed milk.

Refreshment Bars, Restaurants, etc.—There are many bars and restaurants in the neighbourhood of all barracks, where the soldier can obtain suppers and other refreshments, both alcoholic and non-alcoholic, and among the latter milk has an important place.

2. *Investigation of Milk Supplies, including Milk Products.*

It is important to remember that the milk used in barracks is not supplied at the expense of the State, and that consequently the milk for the different units and officers' messes is obtained under arrangements which they themselves make. On the other hand, the milk for hospitals is a public supply, which is obtained under contract arrangements made by the officer in charge of supplies. But, whether public or private arrangements for the supply of goats' milk were the case, the milk was obtained from a large number of different sources. In the case of the hospitals, it was not always herds belonging to the contractor himself that furnished the milk, but, and this is particularly true of the larger hospitals, he gathered together a number of small owners, and from collections of goats thus made up the required quantity of milk was obtained. There was no guarantee that the herds would be composed of the same goats from day to day. Bearing in mind the extent to which the Maltese goat is the carrier of the *Micrococcus melitensis*, it is obvious that frequently changing goats must necessarily mean increased risk of the introduction of infected

milk. In the case of barracks, the herds were more uniform in their composition, and here the risk was dependent on the relative number of healthy and infected goats in the herd. This, it is thought, affords a probable explanation of the irregular distribution of the disease from year to year observed in barracks, and of the want of constancy as regards place infection.

Barracks.—During the first five months of 1906 the garrison could be divided into two sections: (1) Units using goats' milk, and (2) Units using condensed milk. To the first section belonged the 1st Battalion Royal West Kent Regiment, the 1st Battalion Rifle Brigade, the 2nd Battalion Essex Regiment, the 1st Battalion Lancashire Fusiliers, the 4th Battalion Rifle Brigade and the several detachments of the Royal Army Medical Corps. To the second section belonged the Royal Engineers, the Royal Garrison Artillery, the 4th Battalion Worcestershire Regiment, and the detachment of the 2nd Battalion Royal Sussex Regiment. This division refers only to the milk used regimentally in bulk for the men's breakfasts and teas in barracks.

Condensed Milk Units.—It by no means follows that the men of these units had no access to goats' milk. On more than one occasion we found that goats' milk was brought in for individual use in the case of units classed under the condensed milk category. The married families, too, of these units were making use of goats' milk in many instances. The milk supplies of the several officers' messes was goats' milk, or, rarely, cows' milk, which may also convey the micrococcus; and it is noteworthy that officers' servants and mess waiters showed a special liability to contract Mediterranean Fever. The fact that condensed milk was the barrack supply did not prevent the men from using goats' milk outside barracks, as a study of the histories of individual cases will show. It is a popular belief in the artillery, amongst other units, that the men did not often contract Mediterranean Fever in barracks, but that they had to be admitted to hospital to get it.

Cook-houses in Barracks.—Enquiries elicited the fact that it is a common practice for men employed as cooks to taste unboiled milk, mostly in order to decide doubts as to quality, but sometimes it was taken as a drink. Many of these men had daily opportunities of taking unboiled goats' milk, and it is a significant fact that they showed special liability to attack by Mediterranean Fever. Some instances have already been given, and others will be found in the details relating to the investigation of cases.

Use of Milk outside Barracks.—A census of the men of the West Kent Regiment was made in April as to their milk-taking habits outside barracks. The evidence obtained was that, out of 696 men questioned, 153 stated that they had drank goats' milk outside

barracks, some frequently, others occasionally. The forms in which it was taken included goats' milk plain, soda and milk, egg flips, rum and milk, ice cream, milk puddings, and occasionally milk with porridge. Besides the men referred to here, many other men in the regiment had taken tea and coffee outside, to which goats' milk had been added.

During the investigation of cases in barracks, many other parties of men were questioned, and similar information was obtained; for instance, out of a party of 36 artillerymen, 17 stated that they occasionally drank goats' milk outside barracks.

It is also fairly common for soldiers to purchase goats' milk from itinerant vendors at Pembroke Camp. It must be borne in mind, in connection with the division into goats' milk and condensed milk units, that both classes of units come to this camp for their musketry course.

Ice creams, and soda and milk are very freely taken by soldiers and by soldiers' wives and children during the hot weather months.

We satisfied ourselves by personal investigation that goats' milk was to be obtained in the restaurants, and in many of the bars frequented by soldiers. Some bars have quite a reputation for egg flips. We have also seen goats tethered in bars. There must be a demand, or a source of supply would not be on hand.

Hospitals.—The supply in all the military hospitals was goats' milk up to the latter part of May, 1906.

It was ascertained that the cooks in hospital kitchens were in the habit of tasting unsterilised goats' milk, when there was any doubt as to its quality, a practice already pointed out as also common in cook-houses in barracks, and here again cooks show special liability to attack.

In some instances, Mediterranean Fever has been contracted by men whose duty it was to superintend the milking of the goats.

Many soldiers appeared to contract the disease in hospital, and in such cases there was generally evidence that the man had been on milk diet, or that he had been getting milk as an extra.

Soldiers' Families.—A house-to-house visitation of soldiers' families was made, and it was found that some families used condensed milk alone, some both condensed milk and goats' milk, while others used goats' milk entirely. The details of this investigation are given on p. 211.

(1) *Milk Precautions, prior to the Milk Change; Barracks and Married Quarters.*—The infectivity of goats' milk was recognised in 1905, in which year orders were issued by commanding officers that all goats' milk for the use of the men in barracks was to be boiled, and the married people were enjoined to make use of the same precautionary measure. In order to prevent soil pollution, goats were ordered to be excluded from barracks, and milking places were appointed which

were usually just outside the precincts of the barracks or hospital. These instructions remained in force as long as goats' milk continued to be used.

Hospitals.—The goats' milk used in Valletta and Cottonera Hospitals was pasteurised in Aymard sterilisers, a proceeding which dates back to 1904, while in the hospitals at Forrest, Citta Vecchia, Imtarfa and Gozo sterilisation by boiling was practised. Taking Valletta Hospital as the example, the details as to milk precautions were as follows: The average daily quantity of milk used in this hospital, speaking roughly, varied between 180 and 200 pints in the cold weather months, and between 750 and 800 pints in the hot weather months. A non-commissioned officer and three men were told off to superintend the milking of the goats, and each milking was done in the presence of the non-commissioned officer and one of the men. The milk was supplied three times a day, at 6.45 A.M., at 9 A.M., and between 2 and 3 P.M.; and in the hot weather months a fourth supply was usually obtained at 6 P.M. The milk was placed in the Aymard steriliser, and it was raised to a temperature of 195° F. If the water in the outer chamber of the steriliser was boiling when the milk was put in, the temperature of 195° F. was reached in 20 to 25 minutes, and the milk was then kept at this temperature for five minutes. The whole process, therefore, takes over half an hour, and the milk has to cool afterwards. The milk cans were all scalded in the hospital kitchen. Special covered cans were used for conveying the sterilised milk from the kitchen to the wards.

(2) *Failure of Sterilisation.*—The precautions to ensure that only sterile goats' milk was supplied to the troops were excellent, as far as the issue of orders could make them, and theoretically they should have done away with all risk of the spread of the disease through the use of infected milk. But it must be remembered that such sterilisation has to be entrusted to human agency, and it was therefore likely to fail altogether at times, and if circumstances arose which might seem to require that the process of sterilisation should be hurried, it was liable on those occasions to be incompletely carried out. That it did fail is certain, as Colonel MacNeece, the Principal Medical Officer of the Malta Command, informed us that, in the beginning of September, 1905, he had to call the attention of officers commanding to the fact that in some corps goats' milk had not been boiled before use, and he asked that stringent orders might be issued that this must be done by troops and married families. Later, we again find that, while he considered the sterilisation of the hospital milk as generally satisfactory, he still regarded it as doubtful in the case of the troops, and still more doubtful in the case of the soldiers' families, notwithstanding the orders on the subject. Soon after we began our investigations, doubts as to the completeness of the milk sterilisation

became so strong in our minds that we cast about for some means of distinguishing boiled from unboiled milk, and in consultation with the laboratory members of the 1906 working party it was decided to make use of the "Ortol" test.

There are several reagents which give colour reactions with unboiled milk, such as hydroquinone, guaiacol, pyrocatechine, and ortol. The "ortol" test was suggested by Saul in the 'British Medical Journal,' March 21, 1903, for distinguishing between boiled and unboiled milk. It does not distinguish raw from pasteurised milk, as no reaction is obtained until a temperature of 75° C. is reached. Two solutions are required: (1) a solution of ortol, and (2) a solution of peroxide of hydrogen. A few drops of each, added in the order named, give an instantaneous rich rose colour with unboiled milk, no change of colour being observed if the milk has been boiled. The use of the test was started on May 16, and during the next three weeks neglect of boiling goats' milk was detected on six separate occasions. Three of these were in connection with an officers' mess in which cases of the disease had been persistently appearing. The supply of this mess was changed to condensed milk, after which no further cases occurred.

(3) *Laboratory Examinations of Milk.*—Samples of goats' milk from barracks and hospitals, of tea with added milk from barracks, and of milk and butter from an officers' mess, were examined for the presence of the *Micrococcus melitensis*, but on each occasion with a negative result.

(4) *Grouped Cases with a Common Milk Supply.*—The cases that occurred in the West Kent Regiment, both in barracks and in the officers' mess—six of the cases observed in the Misida Bastion married quarters, five cases occurring in three families living in Government quarters in Floriana, a long distance away from any of the cases just mentioned, and the case of an officer living in rooms in another part of Floriana—all had their milk from the same goat-herd. No other relation in common could be discovered, and we know that the herd contained infected goats.

(5) *Examinations of Goats.*—The work of the Commission in 1905 established the facts that a large proportion of the goats examined gave a positive reaction, and that the milk of such goats often contained the disease germ. Amongst the goats examined in 1905 were the following herds supplying milk to the troops:—

1. Valletta Hospital. A small herd of 13 goats was examined; four gave a positive reaction, and the milk of one yielded the specific micrococcus.

2. Citta Vecchia Sanatorium. There were 15 animals in the herd; 11 were found to react, and five gave infected milk.

3. Forrest Hospital. Fifteen goats were examined; five reacted, and from the milk of one the micrococcus was recovered.

The following herds were examined in 1906 :—

1. Herd supplying the 1st Battalion Royal West Kent Regiment. Owing to the prevalence of Mediterranean Fever amongst the officers and men of this regiment, and amongst the married people living in the Floriana district, the goats of the herd supplying Floriana Barracks with milk were examined in the first week in May. The same herd also supplied the officers' mess and a number of soldiers' families. This herd consisted of 40 goats, 10 of which gave a positive reaction, and from the milk of three the *Micrococcus melitensis* was separated.

2. Herd supplying the 1st Battalion Rifle Brigade. This battalion continued to have goats' milk after all the rest of the garrison had changed to condensed milk. Owing to the occurrence of cases of Mediterranean Fever in July, the goats of the herd supplying the milk were examined on the 25th of that month. The herd consisted of 81 milch goats, pregnant goats, kids, and billies. Forty-six of the goats were in milk, and six of them gave a positive reaction, and the micrococcus was recovered from one. Thirty-one specimens of blood from the other goats were examined, and 20 of them were found to react.

3. Valletta Hospital. This herd, or rather the collection of small herds which went to make it up, numbered over 60 goats. It was intended to have examined the whole herd, but owing to objection on the part of the goat-herds, samples of milk from 18 goats only were obtained. Of these six reacted, and the *Micrococcus melitensis* was isolated from one.

4. Citta Vecchia Sanatorium. Thirty-eight examined; 12 gave a positive reaction, and the milk of three yielded the germ.

5. Forrest Hospital. Eight goats were examined; all were found to be healthy.

6. Imtarfa. Sixty goats were examined, and two gave a positive reaction, but the milk of neither yielded the *Micrococcus melitensis.*

It must, of course, be remembered that some of the goats, giving reactions only, would at other times probably be excreting *Micrococcus melitensis* in their milk. From an epidemiological point of view, therefore, reacting goats must be considered as potential sources of danger.

There is evidence that the proximity to living quarters of places where goats are penned, or milked, or which are used as resting places for the goats, is attended by danger of the disease being conveyed to those living in such quarters, and we think that the fly is often a carrier of infection in such circumstances, and that the disease is more likely to be spread by it than through the medium of infected dust. This appears to be the most likely explanation of the occurrence of the disease in Cases 29 and 30 of the West Kent series (*vide* p. 187).

It is possibly also the best explanation of the cases which occurred in 1904 and 1905 among the nursing sisters at Cottonera. Davies informs us on p. 151, Part IV, of the Commission Reports, that it had been the practice, until July, 1905, to milk the goats that provided milk for the patients on a plot of ground within a few yards of the nursing sisters' quarters, and that there is no doubt that this area was extensively fouled every day for a long period. No cases have occurred amongst the nursing sisters at Cottonera Hospital since the goats were removed from this spot.

(6) *Discontinuance of the use of Goats' Milk in Hospitals and Barracks.*—Even if there had been no other facts to go on than that a large proportion of the goats in Malta were infected, and that their milk was a common vehicle for the *Micrococcus melitensis*, we consider that we would have been justified in recommending the discontinuance of the use of goats' milk. But, as early as the beginning of May, the evidence collected had lent strong support to the view that infected goats' milk was a factor of the highest importance in connection with the spread of Mediterranean Fever. The use of milk was a factor which assumed special prominence in the investigation of cases of the disease. It seemed best to explain the occurrence of cases amongst cooks, officers' servants, hospital patients, etc. It was the one common factor that appeared to be associated with the wide-spread distribution of the disease, and it was the one common vehicle which is known to convey the specific micrococcus. Moreover, we had completed the milk census of the West Kent Regiment, and, as the result of special prevalence of the disease in that regiment, the herd supplying the milk had been examined and had been found to be infected. There was, therefore, the association of an infected herd of goats with the special prevalence of the disease in a particular body of men. Doubts had arisen as to the efficiency of milk sterilisation, more especially in barracks, but milk infection was a certainty. The obvious course, therefore, was to cut off the supply of the infected article, both from barracks and hospitals. In discussing the matter with officers and others in barracks, we had frequently been met with the remark, "But, if goats' milk is dangerous, why is its use continued in hospitals"? We found that the regimental authorities were unwilling to move in the direction of change until a lead had been given by the hospitals. The situation was discussed with the Principal Medical Officer, Malta, who referred the matter to the Commander-in-Chief, and, on May 12, orders were issued for the discontinuance of the use of goats' milk in the military hospitals, as a tentative measure, and for its replacement by condensed milk. This change came into operation in the various hospitals between May 18 and 22, and at the same time the use of goats' milk by the various detachments of the Royal Army Medical Corps also ceased.

As the milk supply to barracks and to officers' messes is not a public supply, but is one arranged for by the units themselves, it was decided to try first to get commanding officers to make the change from goats' milk to condensed milk themselves, and also that they should be communicated with direct in the matter, rather than through the medium of orders. Accordingly, direct representations were made to the various commanding officers, but before any practical steps were taken the accomplishment of the desired change was greatly facilitated by the occurrence of a strike of the goat-herds. The strike began on May 15 and ended on June 1. It was distinctly useful in getting the use of goats' milk discontinued in both barracks and officers' messes, as the goat-herds themselves stopped supplies, and they had only themselves to blame when they found that their customers, having made other arrangements, refused to go back to them. The supply of goats' milk was not cut off completely during the strike, as one regiment, at least, got its usual supply throughout the period. There was still some hankering after goats' milk on the part of some units, but at the request of the Principal Medical Officer a lecture was given on the subject of Mediterranean Fever to the officers and warrant and non-commissioned officers of the garrison. This was followed by the almost universal adoption of the milk change, and also by another useful step, namely, the establishment of permanent sanitary staffs in connection with several of the infantry units. By the end of the first week in June all the units of the garrison were using condensed milk, with the single exception of the 1st Battalion Rifle Brigade, which continued to use goats' milk up to the time the battalion left Malta for England in October. This regiment was not pressed to make the change, as it was known to have very complete arrangements for the sterilisation of the milk, and from the personal equation point of view it was felt that the individuals concerned in the supervision of the sterilisation could be trusted. There was also the further reason that it to some extent provided a control, which might in the end prove useful for purposes of comparison in connection with the milk change. In this connection it is a significant fact that cases of Mediterranean Fever were admitted from the 1st Rifle Brigade in July, August, and October, whereas the 4th Rifle Brigade, which occupied the neighbouring barracks of St. George's, Pembroke, and which had adopted the condensed milk change, had its last admission for the disease in May.

3. *Distribution of Cases in* 1906.

Table X.

Units.	Date of arrival. From—	Barracks.	Distribution of cases by months.											
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1st Bn. Royal West Kent Regiment	15/4/04 England	Floriana	7	3	6	6	8	10	—	2	2	—	—	—
1st Bn. Rifle Brigade	20/4/04 England	St. Andrews	1	—	—	—	2	—	3	1	—	1	—	—
2nd Bn. Essex Regiment	28/4/04 England	Imtarfa	—	—	1	1	2	2	—	1	1	1	—	—
2nd Bn. Royal Sussex Regiment ...	27/6/04 England	"	—	—	—	—	—	—	—	—	—	—	—	—
1st Bn. Lancashire Fusiliers	27/2/05 Gibraltar	Lower St. Elmo and Manoel	2	1	3	—	—	—	—	—	1	1	—	—
4th Bn. Rifle Brigade	16/11/05 England	St. George's	—	—	—	1	4	—	—	—	—	—	—	—
4th Bn. Worcestershire Regiment	2/12/05 Barbados	Verdala	—	1	—	1	—	—	—	2	—	—	—	1
Royal Engineers	—	St. Francis	1	—	—	1	2	3	—	—	1	1	1	—

Royal Garrison Artillery— No. 1 Company	12/11/04 Gibraltar	Tigne	1	—	—	1	—	1	1	—	—	—	—	—
5 „	12/11/04 Gibraltar	Ricasoli	4	—	1	—	—	—	—	—	—	—	—	—
63 „	16/10/02 South Africa	„	1	—	1	1	—	—	—	—	1	—	—	—
65 „	4/11/04 India	Upper St. Elmo and	1	—	—	—	3	—	2	—	1	—	—	1
96 „	9/10/02 Gibraltar	St. James Cavalier	1	—	1	1	—	1	—	—	1	—	1	—
99 „	17/11/03 Gibraltar	Tigne	2	—	—	1	1	3	2	1	—	1	—	—
100 „	17/11/03 Gibraltar	Ricasoli	1	—	1	1	—	—	—	—	—	—	—	—
102 „	29/9/04 Gibraltar	Tigne	—	3	—	—	3	—	3	1	—	—	—	—
Army Service Corps	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Royal Army Medical Corps	—	—	3	3	1	3	5	1	—	—	2	—	—	—
Army Ordnance Corps	—	—	—	—	—	—	—	1	—	—	1	—	1	—
Army Education Department	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Miscellaneous	—	—	—	—	—	—	—	1	—	—	—	—	—	—
	Total admissions		25	11	16	18	30	23	11	8	11	5	3	2
	Excluding re-admissions		21	8	15	18	29	21	9	8	8	2	3	2

In five of the cases debited to January, and in one debited to February, the diagnosis was then made, but the men were admitted to hospital in the previous year. These cases have been included in the 1906 figures, as they did not appear in the 1905 returns.

1. Private P., F Company, Royal West Kent Regiment.—Admitted October 5, 1905, from Room 3, Old Floriana Barracks. He had been employed in the cook-house for two months before admission. He was on milk in hospital from December 4 to December 12, 1905. A positive serum reaction was first observed on January 26, when Mediterranean Fever was diagnosed.

2. Private L., G Company, Royal West Kent Regiment.—Admitted for simple continued fever on November 13, 1905, to Cottonera Hospital, and transferred to the sanatorium at Citta Vecchia on December 24, where Mediterranean Fever supervened 21 days after transfer. He was on milk in Cottonera Hospital from November 22 to November 30, 1905, and again at Citta Vecchia from January 2, 1906.

3. Gunner S., No. 1 Company, Royal Garrison Artillery.—Admitted for bronchitis on December 31, 1905, and disease was changed to Mediterranean Fever on January 18, 1906.

4. Private E., 1st Battalion Rifle Brigade.—Admitted for rheumatism on December 31, 1905, from F Block, St. Andrew's Barracks. The disease was changed to Mediterranean Fever on January 21, 1906. There is a history that this man drank goats' milk freely prior to admission.

5. Gunner S., No. 65 Company, Royal Garrison Artillery.—Admitted for gonorrhœa on December 31, 1905, from Room 40, Upper St. Elmo Barracks. The disease was changed to Mediterranean Fever on January 10, 1906.

6. Bombardier S., No. 102 Company, Royal Garrison Artillery.—Admitted for psoriasis to Valletta Hospital on October 17, 1905, and transferred on December 6 to the sanatorium at Citta Vecchia, where symptoms of Mediterranean Fever were observed on February 6, 1906, and a positive serum reaction was obtained four days later.

Distribution of Cases.

Of the 163 admissions for Mediterranean Fever in 1906, 19 were re-admissions for the disease. The re-admissions were distributed in units as follows:—1st Royal West Kent Regiment, six; Royal Garrison Artillery, five; 1st Lancashire Fusiliers, four; 2nd Essex Regiment, three; and Army Ordnance Corps one—and in point of time: January, four; February, three; March, one; May, one; June, two; July, two; September, three; and October three.

Excluding re-admissions, the cases which occurred in the four quarters of the year were as follows:—

January to March.	April to June.	July to September.	October to December.
44	68	25	7

Two points should be borne in mind in regard to these figures—(1) that the second six months is the half of the year when Mediterranean Fever is usually most prevalent, and (2) that the first six months was the period *before* the milk change, while during the

second six months goats' milk had been discontinued in all the hospitals, and in all but one of the barracks.

4. *Prevalence in Units.*

Royal Garrison Artillery.—As has already been indicated, and as will be seen later when the individual cases are being discussed, a considerable number of the cases which have occurred in the artillery units were those of men who have taken goats' milk either in or outside barracks, while some of the others are instances in which there is a strong probability of the disease having been contracted in hospital. The artillery units show a very marked decrease of prevalence during the second half of the year, with 16 admissions against 35 in the first six months.

1st Battalion Rifle Brigade.—This battalion arrived in Malta on April 20, 1904, from England. They were quartered in Manoel Barracks for the first 13½ months, and were moved in June, 1905, to the newly built St. Andrew's Barracks, of which they were the first occupants. Mediterranean Fever appeared in the regiment six weeks after its arrival, and cases occurred every month afterwards up to January, 1906. There was then freedom from fever cases until May. On the occurrence of three cases in July, the goats supplying the battalion with milk were examined, and the herd was found to be infected. It is of course possible that the disease was contracted outside barracks, but we failed to trace any outside source, and as we know that the milk was coming from an infected herd of goats, notwithstanding the very strict supervision exercised over the boiling of the milk in this battalion, failure of sterilisation cannot be excluded.

4th Battalion Rifle Brigade.—This battalion arrived from England on November 16, 1905, and were quartered in St. George's Barracks, Pembroke, which are in the near neighbourhood of the barracks of the 1st battalion of the regiment. The first case of the disease occurred four and a half months after arrival, and there have been five cases in all, one in April and four in May. There have been no cases since the milk supply of the battalion was changed to condensed milk.

2nd Essex Regiment.—Arrived in Malta from England on April 28, 1904. This regiment suffered severely in both 1904 and 1905, when it contributed 79 and 113 admissions respectively. During the first 14 months of its stay it was stationed at Lower St. Elmo, after which it was moved to Imtarfa, where it has since remained. There have been only nine admissions in 1906, six in the first half of the year and three in the second. Of the latter, one was a case from Gozo, and both in this and one other of the three cases there is a history of taking goats' milk. The milk supply of the regiment was changed from goats' milk to condensed milk on June 7.

1st Battalion Lancashire Fusiliers.—This regiment came from Gibraltar to Malta on February 27, 1905, and the first cases of Mediterranean Fever were admitted in the following April, and cases occurred every month until the regiment left for Egypt on April 30, 1906. There were 75 admissions in 1905, while in 1906 there were eight admissions, four of which were re-admissions, two in the first three months of the year and one each in September and October. Two cases of Mediterranean Fever were admitted in Egypt on July 7, one from the officers' mess and the other from No. 5 Room, L Block, Citadel Barracks. Both men arrived from Malta on May 3. Cows are kept at the Citadel Barracks, and this milk is not boiled before issue. We have no information as to the presence or absence of the *Micrococcus melitensis* in milk in Egypt. The regiment returned to Malta from Egypt on December 17.

2nd Battalion Royal Sussex Regiment.—The headquarters and 500 men of this regiment left Malta for Crete on May 29, 1905. A detachment remained and were quartered in Imtarfa Barracks until April 30, 1906, when it left Malta to join headquarters. There were no cases of Mediterranean Fever in 1906 up to the time of its departure. The milk supply was condensed milk.

4th Battalion Worcestershire Regiment.—This regiment arrived in Malta from Barbados on December 2, 1905, and were quartered in Verdala Barracks. The first case of Mediterranean Fever was admitted on February 11, 1906, but we have no evidence as to the probable source of the disease, except that the man was in hospital from December 2 to 12, 1905. The second case was admitted on April 16, and was that of a married man, whose child was admitted for Mediterranean Fever on March 2, and for both cases there is a goats' milk history. The milk supply of the regiment is condensed milk, dating from its arrival in Malta. The regiment was sent to Alexandria, where it arrived on May 11, and it returned to Malta on June 12. Six cases of Mediterranean Fever were admitted during its month's stay in Egypt. There was an entire absence of Mediterranean Fever from the garrison of Alexandria until the arrival of the Worcestershire Regiment from Malta, and the only cases then observed were those among the men of that particular regiment. We have been unable to obtain any evidence which throws any light as to the source of the disease in these six cases. The men appear to have been admitted for simple continued fever in four of the cases and for rheumatism in the other two, and the disease was changed afterwards to Mediterranean Fever. A positive serum reaction was obtained in each of the six cases. After returning to Malta, two more cases were admitted in August; one was a man who had been feeling out of sorts ever since his return from Egypt, the other was a man admitted on August 13 from Gozo, where he had

been stationed since July 2, and where he had been employed as a cook. There is no evidence of the use of goats' milk in either of these cases. Another case was admitted in December, but of this case we have no particulars.

The units showing the greatest prevalence of Mediterranean Fever in 1906 were the 1st Battalion Royal West Kent Regiment and the Royal Army Medical Corps, the special prevalence, however, being confined in both instances to the first half of the year. The details are given fully in the following section of the report dealing with the analysis of cases of Mediterranean Fever.

5. *Analysis of Cases of Mediterranean Fever.*

Though the analysis of the cases generally only gives brief details, yet each case was examined in a systematic manner on a special form arranged for the purpose. We found the forms of very great assistance in recording cases. The principal points noted in each case were: 1. The barrack room or place from which each case was admitted. 2. The date of the onset of attack, together with a history of the man's previous state of health, and the date on which his blood reacted against *Micrococcus melitensis*. 3. Date of admission. 4. Whether a first attack or relapse. 5. Movements since arrival in Malta, giving dates which were confirmed by reference to official information obtained from the unit to which the man belonged. 6. More particular information about the man's movements during the 30 days before he got ill. 7. Particulars of previous illness in Malta from his medical history sheet. 8. If single or married, in the latter case enquire *re* health of other members of family. 9. Conduct and habits, teetotaller, moderate drinker, drinks freely, and enquiries as to visits to brothels, giving dates. 10. Actual nature of employment: on this point we found it to be of the very greatest importance to get full information, as it gradually came out that certain employments were found to be frequently associated with attacks of Mediterranean Fever; for example, cooks, mess waiters, and officers' servants. 11. Any special hard work or exposure during 30 days before illness. 12. Any facts bearing on defective drainage, dust, latrines, urinals, etc. Whether employed in cleansing W.C.'s., urinals, or moving urine tubs during 30 days preceding illness. 13. Facts concerning milk consumed, including butter, cheese, or other articles into the composition of which milk enters. If the man had consumed any fresh goats' or cows' milk during the 30 days preceding; give dates if possible. 14. Apart from barrack ration meals, particulars relating to articles partaken of in barracks, such as milk, other foods, uncooked vegetables, fruits, aerated waters, etc. 15. Articles of like nature partaken of outside barracks

and where; dates if possible. 16. Facts relating to mosquitoes and other biting insects (*a*) in barracks; (*b*) out of barracks. 17. What contact has there been with recent cases of the disease (*a*) personal? (1) Contact with previous cases before their removal to hospital. (2) Presence of convalescents in barrack rooms; this included blood examination and, in some cases, examination of urine. (*b*) Through clothing and bedding. (*c*) Issue of articles from store. 18. Position of bed in barrack room and relation, if any, to previous cases. 19. Precautionary measures adopted with regard to previous cases. 20. Miscellaneous facts in relation to each case.

During the year 1906, up to the end of September, 153* cases of Mediterranean Fever had occurred among the non-commissioned officers and men of the British troops in Malta. Of these, 108 are possible cases of infection through goats' milk, *i.e.*, 70·6 per cent. of the cases. They are cases (1) of men who are known to have drunk goats' milk freely, the source of which was known later to have been from a herd which contained infected goats. (2) Of men who are known to have drunk freely goats' milk about the source of which nothing is known, beyond the fact that they got it from a passing goat-herd, or in a restaurant, or in the houses of private individuals. (3) Of men who had taken goats' milk in egg flips or with rum in different public-houses. (4) Of cooks who said they only drank it boiled. (5) Of men who drank goats' milk in hospital. (6) Of men who said they only had it in tea other than the regimental tea. (7) Of men who said they only had it in tea in barracks.

The last group is a small one, but, we believe, not an unimportant one, though we have not classed any of these cases among those of probable milk infections. The incidence of the disease on goats' milk-drinking regiments is an argument in favour of the inclusion of such men as possible cases of infection through milk. The 1st Rifle Brigade in St. Andrew's Barracks, the newest and best run barracks in Malta, gave nine cases of Mediterranean Fever during the year. This regiment continued to use goats' milk for the men's tea until they left Malta on October 1, 1906. The 4th Rifle Brigade, which lay near the 1st Rifle Brigade in St. George's Barracks, gave five cases of Malta Fever. This regiment discontinued the use of goats' milk on May 15, and their last case of Malta Fever was admitted to hospital on May 29, 1906 (Private M.). The last case from the 1st Rifle Brigade was admitted to hospital on October 19 (Private P.).

The Royal West Kent Regiment had 44 cases. This regiment discontinued the use of goats' milk on May 15. Up to June 15, 35 cases took place, or 79·5 per cent. of all the cases, while only nine

* The total number of cases for the year is 163, the 10 further admissions occurred after we had left Malta.

cases, or 20·5 per cent., took place between June 15 and the end of September, the time of greatest prevalence in past years. These figures really understate the case, as two out of the nine cases include two relapses, one, Private H. H., a relapse from June 15, 1906, and Corporal T., a relapse from November 27, 1905, and another man, Lance-Corporal R., who was admitted on July 9, 1906, used to get goats' milk to the middle of June, and must therefore be included in the list of possible milk infections. The figures thus corrected give 86·4 per cent. of possible milk infections.

The Royal Army Medical Corps gave 18 cases up to the end of the year. The use of goats' milk was discontinued at Valletta Hospital on May 21, at Cottonera Hospital on May 22, 1906, at Forrest Hospital on May 18, 1906. Fifteen of the 18 cases occurred before or a few days later than June 22, while of the remaining three cases, one, Private J., admitted on June 19, 1906, but ill since June 11, 1906, acknowledged that he had drunk unboiled goats' milk about a fortnight before the condensed milk was taken into use, *i.e.*, on or about May 8, and another of the cases was that of Lance-Corporal J., who was almost certainly infected while working in the laboratory of the Mediterranean Fever Commission, and the last was the case of Private B., admitted September 16, 1906, but who had been feeling unwell practically since May. (See Case 18, Royal Army Medical Corps.) It is thus seen that 88·9 per cent. of the Royal Army Medical Corps cases occurred before goats' milk was stopped in the hospitals. The Royal Army Medical Corps furnished 11·4 per cent. of all the cases during the year.

Though we do not think that all these cases were milk infections, it is a striking fact that so many cases occurred during the time goats' milk was in use in the hospitals, and so few after its discontinuance.

The cases have been divided into the following groups:—

Series 1.—The cases in the 1st Royal West Kent Regiment.
Series 2.—The cases in the Royal Army Medical Corps.
Series 3.—Hospital cases.
Examination of the Diet Sheets of patients in Valletta Hospital during 1905.
Series 4.—Other cases of possible milk infection.
Series 5.—Cases in which the patients were probably infected through animals other than goats.

Series 1.—*The Cases in the* 1*st Battalion Royal West Kent Regiment.*

This regiment, as in the previous year, occupied Old Floriana Barracks, New Floriana Extension, and Notre Dame Ravelin Barracks and Huts, and Salvatore Counter Guard. The structural arrangements and sanitary shortcomings of the old barracks have been fully detailed by

Lieut.-Colonel A. M. Davies in last year's Report, and need no recapitulation here. Suffice it to say that the local authorities had done their best to remedy such defects as were remediable, and had taken good care, by provision of ample tentage, that no overcrowding took place in the casemate rooms. Further, on the recommendation of Colonel MacNeece, Principal Medical Officer, Malta Command, the casemate barracks were evacuated on July 11, 1906, and the portion of the regiment thus displaced was quartered in Fort Manoel Hutments. This regiment, in 1906, up to their departure from Malta in October, gave 44 cases, or, excluding six relapses, 38 cases. Of these, 40 occurred up to the end of July, and only four during August and September. It must be understood that the change to Manoel Hutments affected only about 250 men of the regiment, the rest of the regiment remaining in New Floriana Extension and Notre Dame Ravelin and Salvatore. The position of the Civil Hospital over the regimental offices and facing the casemate barracks has been remarked upon by Lieut.-Colonel Davies. We noticed the presence of numerous flies in Old Floriana Barracks, in spite of the fact that the barracks were kept in a very clean condition. This regiment, on the suggestion of the Commission, adopted the plan of having a fixed establishment told off permanently for sanitary work, and it was very well done. We had noted the presence of very many flies in the Civil Hospital, and we have little doubt that the Civil Hospital was the principal source of the flies in Old Floriana Barracks. The Civil Hospital contained many cases of Mediterranean Fever, and we think that the common fly may be regarded as a possible carrier of germs from milk and possibly from infected urine. Another noticeable feature of the surroundings of Floriana Barracks, old and new, was the large number of goats which were constantly crossing the regimental parade ground on the way to and from Valletta and Misida, and Valletta and Hamrun. Further, it was the custom to keep a herd of goats at the back of C Block, Floriana Extension, in a small ravine shaded by trees, all day and every day. There were always swarms of flies in this ravine, on and about the goats, and the place was used as a latrine by the goat-herds. This ravine was at a very short distance from the back of the barracks. Another herd of goats was kept in the ditch between Floriana Extension Barracks and the back of the new married quarters, Misida Bastion. This herd used to graze on the slope of the ditch at the back of the married quarters. We inspected many sheds in which goats were kept in Malta, and always noticed numbers of flies upon the goats. This was so marked as to force them on our attention as possible or rather probable carriers of infection.

We will now discuss in detail the cases of the West Kent Regiment during 1906:—

1. Private P., F Company, was admitted to Valletta Hospital on October 5, 1905, and his blood was found to react on January 26, 1906. He had been in No. 3 Room, Old Floriana Barracks, for six months, and he was the first case which had occurred in his company for over six months. He had been in hospital in May, 1905, with sore throat. There is no evidence of contact. This man drank unboiled goats' milk and soda water, egg flip, and took porridge and milk outside barracks, in fact, was a fairly free milk drinker up to the time he got ill. His history makes it clear that he exposed himself freely to the risk of infection through milk.

2. Private L., G Company (see Hospital List No. 1). We think the disease was contracted in Citta Vecchia Hospital; if the disease was Mediterranean Fever from the beginning of his illness, it was possibly contracted through fly infection from the herd at the back of C Block, New Floriana. This man was not personally interviewed by us, as he was invalided before we reached Malta. We therefore know nothing about his drinking milk or not before he went to hospital; we do know, however, that he had been employed in a cook-house for two months before he got sick.

3. Private D., C Company, was admitted from No. 14 Room, Notre Dame Ravelin, on January 10, 1906, and was a relapse from December 27, 1905. He had been in Valletta Hospital—October 23 to November 13, 1905—with enteric fever, and again—November 27 to December 27, 1905—with Mediterranean Fever. He had been in Room 14 before both of these admissions, and had been company cook for three months before his enteric admission. This man states he never drank milk except in his tea. His occupation of cook makes the statement suspicious. No other case occurred in the room, and no other case had occurred for the previous six months. The disease may have been contracted in Valletta Hospital, where he had enteric, or in his work as a cook, when he had to handle milk and milk vessels.

4. Private O., C Company, was admitted from No. 6 Room, Notre Dame, on January 23, 1906. He had been in this room since he came out of hospital on November 27, 1905. He then was in from November 7 to November 27 with simple continued fever, and had exactly the same symptoms as he had in the present attack. On that occasion his blood did not react. He had three milk diets, and a pint of milk daily all the time he was in hospital. He states he never had plain milk outside hospital, but he has had tea frequently down town. We think this case is a probable relapse from last year. We can form no opinion as to how or where the disease was contracted.

5. Private B., F Company, was admitted from No. 4 Room, Old Floriana, on January 23, 1906. He had felt ill for three days. He was employed as company cook for two months before he got ill. He drank unboiled goats' milk daily while in that employment. Case No. 1, Private P., came from the same company, but had no contact with him, and came from another room. This, in our opinion, was an almost certain case of milk infection.

6. Private B., E Company, was sergeants' mess waiter. He was admitted January 31, 1906, and was a relapse case (October 12 to November 18, 1905). He lived in No. 3 Room, B Block, New Floriana Barracks. There was no case for four months from the room before his first admission, and none since during the year 1906. He was employed as waiter in the sergeants' mess before and after his first attack. States he never drank plain goats' milk, only took it in his tea. He had to handle goats' milk as a waiter. There is no evidence of contact.

7. Private S., D Company (relapse from October 13 to December 9, 1905). He came from No. 9 Room, Old Floriana, and had been in it since his discharge

from hospital in December. States he never drank goats' milk except in tea, in barracks, and down town. Private S.'s second admission was on January 31, 1906. Another man, Private B., was admitted from this room on April 29, 1906. The room had been disinfected in the meantime. Their beds were far apart on opposite sides of a long room. They were not companions. We can form no opinion how S. contracted his disease.

8. Private M., C Company, was the third case from this company during the year. He was admitted February 6, 1906, from Hut 5, Notre Dame. He had not been in the same room as either of the two previous cases in his company. This case was a relapse from November 26, 1905, to January 22, 1906. He was not personally interviewed by us, but we were informed by a man of his company with whom he "knocked about" that he drank goats' milk and egg flips frequently before his illness. This was a probable milk infection.

9. Sergeant A., G Company, the second case from the company, was admitted from C Block, New Floriana, where he had a small room to himself. This room looked into the goat-frequented ravine at the back of C Block. He had goats' milk in tea, and with porridge, at the sergeants' mess. There is no evidence of contact. We think this was either a milk infection or a fly infection from goats.

10. Private M. (see Hospital List No. 4). He came from Room 5, Old Floriana Barracks, and was only nine days in it before his admission to hospital.

11. Lance-corporal B., E Company, had been at Ghain Tuffieha for 15 days, then came to New Floriana, A2 room, where he remained for three days before his admission to hospital on March 4, 1906. He was not seen by us personally, but the colour-sergeant of his company informed us that he frequently drank goats' milk. He also had it in tea. He was the only case from Room A2 during the year. He contracted his disease either at Ghain Tuffieha or in Hut 8, Notre Dame, in which he had been before he went to Ghain Tuffieha. He ran the risk of infection by milk.

12. Private W., A Company, admitted March 6, 1906, from Room A1, New Floriana; had been at Ghain Tuffieha during the time Lance-corporal B. was there, but not in the same tent. W. was an officer's servant, whose master got Mediterranean Fever just after his return from Ghain Tuffieha. This man said he only drank milk in his tea, but he had tea in the mess, and had access to milk there. We think master and man got the disease at the same place, most probably in the officers' mess.

13. Private P., F Company (see Hospital List, Case 5).

14. Private P., B Company, was admitted from No. 5 Hut, Notre Dame, on March 15, 1906, having felt ill since February 20, 1906. He had been in Cottonera Hospital with gonorrhœa from November 19, 1905, to January 9, 1906. He was the first case from his company during the year, and the history of the case throws no light on its causation. He only had milk in tea, elsewhere than in Cottonera Hospital.

15. Private A, H Company, was admitted from Floriana, New, B4 room, on March 26, after feeling ill for three days. He had been at Ghain Tuffieha from February 21 to March 3. He was employed as company cook for six months before his illness, and we have positive evidence that he frequently drank goats' milk when so employed. There is no evidence of contact.

16. Private P., A Company, was employed as company cook in the same cook-house as Private A (see above). He was admitted on March 28, after feeling ill for two days. He came from Room 3A, New Floriana, but was admitted from Pembroke Camp. He was the first case from the room during the year, and, beside the fact that he worked in the cook-house with Private A., we can find no other evidence of contact. Stated he only took milk in his tea, a statement

which there is reason to believe is untrue. We consider these two cases as almost certainly due to goats' milk.

17. Private R., F Company (see Hospital List, Case 12).

18. Private L., B Company, was admitted on April 16, 1906, from a servant's room in the officers' mess. He was an officer's servant. He had no known contact. States he never drank milk except in his tea. He had access to it in the mess, and had to handle milk vessels. We consider him a milk infection.

19. Private S. H., B Company, Royal West Kent, was admitted April 17, 1906; had no previous illness in Malta, a married man, lived in 11, Floriana married quarters. No milk, except condensed milk, was used in his quarters, and he stated that he had never tasted goats' milk, even in his tea. His wife confirmed his statement. He had eaten no uncooked vegetables or fruit. None of the family have been, or are, ill. The quarters were in excellent sanitary condition. There is no history of contact. He was occasionally employed on latrine fatigues, and was so employed about eight weeks before he got ill. We could form no opinion as to the origin of his disease.

20. Private S., E Company, admitted April 21, 1906, from Room 6, Old Floriana Barracks. He had been in this room one week, before then he was in Room 3, B Block, New Floriana, where he slept in a bed opposite Private B. (see Case 6, above). He had been in hospital—February 1 to February 16, 1906—with simple continued fever, and said he never felt well after he came out. He was an officer's servant, and his master, Captain P., got ill soon after his servant. He used to drink milk in his master's quarters. We know that Private S. and Private B. had slept in opposite beds in the same room, before Private S. got ill, but no other relation could be made out between the cases. We think S. and his master are probable milk infections about the same time.

21. Private F., F Company, was admitted from Pembroke Camp on April 23, 1906. He had been in Cottonera Hospital with gonorrhœa—October 8 to December 6, 1905—and said he had never felt well since. From Cottonera Hospital he went to Room 4, Old Floriana Barracks, from December 6, 1905, to February 13, 1906; then to Corradino Military Prison to February 18; then Ghain Tuffieha, February 19 to March 3, 1906; then Old Floriana, Room 4, from March 3 to March 23; then to Pembroke Camp. Private B. (Case 5 above) came from Room 4 on January 23. He occupied the bed nearly opposite to Private F.'s bed. They were not companions, and had nothing to do with each other. F. frequently drank egg flips, which contained goats' milk. On March 31 he had a surfeit of this drink with a comrade who was "standing him treat."

22. Private B., D Company, was admitted from Room No. 9, Old Floriana, on April 29. He had been employed as company cook for two months before his admission, and used to taste unboiled goats' milk when so employed. Private S. (Case 7 above) came from the same room. They were the only two cases from the room during the year. We think this was a milk infection.

23. Private P., E Company, came from No. 6 Room, Old Floriana Barracks, and was admitted on May 1, 1906. There is no evidence of contact. Private P. was company cook, and states he used to drink goats' milk in the kitchen, where it was sterilised, but only after it was boiled. He had no previous illness in Malta, and felt perfectly well until three days before his admission. We think he was a milk infection.

24. Private B., H Company, was admitted from Room 2B, New Floriana, on May 2, 1906. He had been in this room since March 3, 1906. This was the only case from the room during the year. He was an officer's servant. States he only drank milk in his tea, but he had access to milk in the mess, where we think he contracted his disease.

25. Private R., C Company, was admitted from Pembroke Camp—where he had been from April 13 until date of admission—April 30, 1906. Before then he had been in No. 9, Notre Dame. Date of his admission is shown as May 4, but he was a transfer from Forrest on April 30, 1906. He had been company cook since December. He said he had drank milk in the cook-house, but once only, during the month before his admission. There was no other case from No. 9 Room, Notre Dame, during the year. We think this was a milk infection.

26. Corporal B., F Company, was admitted from No. 6, B Block, married quarters, on May 7, 1906. There were three other cases from this family, and all within a short interval of time:—1st. Rose B., aged 8 years, first felt ill on April 21, 1906. 2nd. Corporal B., first felt ill April 30. 3rd. Oliph B., who first felt ill about April 28. 4th. Edith Maud B., who had been ill since about May 9. There were three other members of the family living in the same quarters—Mrs. B., Mabel B., and Ernest B., none of whom, though apparently equally exposed to infection, contracted the disease. A son Walter had Mediterranean Fever in the summer of 1904, when living with his father's family, and none of the rest then contracted the disease. The family then lived in 13, Strada Magazzini. The son Walter never lived in their present quarters. They came to their present quarters in February, 1906. As the children sickened, they each slept in turn with the mother, while Mabel and Ernest slept in the bed with Oliph before she was known to be ill, and for some time afterwards. Corporal B. slept in Rose's bed, when Rose got ill and was put in her mother's bed. The members of the family who remained well had at least as close contact with the sick as the sick had with each other. The evidence about milk is somewhat conflicting. When the family came from Strada Magazzini to their present quarters in February, they changed from condensed milk to goats' milk, got from the herd which supplied the West Kent Regiment, and which a little later was known to contain infected goats. This evidence was got from Mrs. B. at the time a milk census of the married families was made, when as yet no members of the family were ill. Mrs. B. then stated that the family had been using goats' milk for two months. When Rose got ill, Mrs. B. stated goats' milk was used, but always boiled. When Corporal B. got ill he said goats' milk was only used for tea. When Oliph got ill, Mrs. B. modified her first statement, and said that goats' milk was only taken after Rose got ill. On one occasion, when one of us visited the house to get samples of blood, the children, during the mother's absence on a visit to the father in hospital, were found having tea, and were then using goats' milk. Another child from a quarter on the same verandah, who had only recently come out of hospital after an attack of Mediterranean Fever, was then playing with them. Contact cannot be denied, but: (1) None of the family got it when Walter had it in 13, Strada Magazzini; (2) Mrs. B. did not get it, though apparently more exposed to infection than any other member of the family, through sleeping with infected children; (3) Neither Mabel nor Ernest got the disease after having slept with Oliph before and after she got ill. The history illustrates the difficulty of obtaining accurate information about the use of milk. The obvious deduction, we think, where goats' milk comes into a house, whether stated to be used only for tea, or boiled, is to look on it with equal suspicion as though stated to have been used unboiled. We think the weight of evidence points to this outbreak having been due to the use of infected goats' milk.

27. Private B., F Company, was admitted on May 29 from Room 3, Old Floriana, where he had been for two months before his illness, after feeling ill for two days. Two other cases had come from this room during this year (Cases 13 and 17 above), but on both those occasions the room had been evacuated and lime-washed, etc. B.'s bed was on the opposite side of the room to those of the other two cases. The

history of this case throws no light on its causation. We believe it was possibly caused by infected flies. He had milk in his tea.

28. Private J., D Company, was company cook in Old Floriana cook-house for 14 months. He had no previous illness. He was admitted on May 22 from Room 10, Old Floriana Barracks, from which there had been no previous case during the year. He used to drink a pint of unboiled goats' milk daily. The herd which supplied this milk was found about this time to contain 11 infected goats.

29. Private K., G Company, came from 3c Room, New Floriana, and was admitted May 23, 1906. Says he only had milk in his tea. The history throws no light on the causation of the disease. C Block was much exposed to flies from herds of goats which sheltered at the back of the quarters. There is no evidence of contact, and no other case came from the room.

30. Private H. belonged to the same company as the last case, and came from the room underneath the one Private K. had come from. He was admitted two days later than Private K., *i.e.*, May 25, 1906. Private H., too, only had milk in his tea. We believe these two cases were probably fly infections from the goats which sheltered near the barracks.

31. Private H., A Company, was admitted on June 6; his blood reacted on the same day. He began to feel ill on June 2. He had been in 4 Room, A Block, New Floriana, for seven weeks before his admission. Before then he had done a short period of duty in the Military Police, and lived in 33 Hut, Tigne. He then did clerk's work in the regimental pay office, then ordinary duties, and at the time he went sick was doing a course of gymnasium. He only had milk in tea (and that condensed milk) since May 15. He never had food out of barracks. He had spring onions and cheese for supper frequently. There were two other cases from Hut No. 33, Tigne, during the year. This was the police hut, and the occupants were constantly changing. The two other cases were a soldier of the 2nd Essex Regiment, who was admitted on May 7, and a soldier of the 4th Rifle Brigade, who was admitted on May 21. These three men were in 33 Hut, Tigne, together, but they were not even acquainted with each other, and their beds were in different parts of the room. The room, No. 10, Old Floriana, from which Private H. was admitted to hospital had been occupied by Private J. (Case 28), but it is quite certain that Private H. did not contract his disease in No. 10 Room. He was feeling ill when he went to it, and was only in it two days. We can form no opinion as to the origin of this case, and do not think known contact can explain it.

32. Private I., G Company, was admitted from Ghain Tuffieha on June 6. He had been cook in the sergeants' mess since April 21, 1906. Said he only felt ill for three days before he went sick, but possibly was not feeling too well before then, as, having been a moderate drinker, he had become a teetotaler about three weeks. Before he went to Ghain Tuffieha he was employed as a company cook in Floriana Barracks, and he then drank goats' milk. He lived in Room 1, C Block, New Floriana, a room which looks into the goat-frequented ravine, which we have mentioned before. The cook-house at Ghain Tuffieha, when we visited it, was swarming with flies. Goats' milk was said not to be used in this cook-house. A large number of the ponies at Ghain Tuffieha were found to react to *Micrococcus melitensis*. The case was either a case of fly infection at Ghain Tuffieha or, as we think more probable, was contracted when he was cook at Floriana Barracks, and that the case, like many, is merely one of long latency.

33. Quartermaster-Sergeant C., D Company, was admitted on June 12, 1906, from 24, A Block, Married Quarters, Misida Bastion. His wife, an almost certain milk infection, had been admitted on May 7 with the same disease. Quartermaster-Sergeant C., and his wife, got ill about the same time. Mrs. C. drank goats' milk

freely, but said it was always boiled. Mr. C. said it was generally boiled, and he used it only for tea. Two boys, Stephen and John, never drank milk, and remained apparently quite well, though the blood of both boys gave a good positive reaction to *Micrococcus melitensis*. They were both strong, active lads, who on many occasions showed us round different places near these married quarters. They remained well all the season, and took hard exercise daily. We think the whole family were infected at the same time, and that the agent was infected goats' milk. There is no evidence of contact except among the members of the family. Husband and wife occupied one room, the boys another. The urines of both boys were examined on several occasions, with negative results.

34. Private S., B Company.
35. Private H. H., C Company.
36. Private K., C. Company.
37. Private H. W. G., C Company.

The four cases above are important from the point of view of place infection. Case 36 we think to be a probable case of milk infection. In the other three cases we have been unable to obtain any history of milk drinking. From the point of view of place infection they must all be considered together. Private S. had no previous illness in Malta. He first felt ill on June 11, with giddiness, and was admitted to hospital on June 14, 1906. His blood reacted on the same day. He was probably ill longer than he said, as, having been a great cigarette smoker, he had given it up entirely a fortnight before he went sick. He had never drunk goats' milk, and since May 15 only had condensed milk in his tea. There is nothing in his dietary or manner of life to suggest a clue to the probable source of his illness. He was admitted from Room 6, Notre Dame, but had been in it only since June 5, ten days before his admission, and six days before he felt ill. Before June 5 he had lived for over two months in Room No. 8, Old Floriana Barracks. He was the first case this year which occurred in Room 8, and it is quite clear that the case belongs to No. 8 Room rather than to Room 6, Notre Dame. It was noticed at this time how numerous the flies were in Floriana Barracks, and it was now that we visited the Civil Hospital, and found it very full of flies also. It was suggested that the windows of the hospital should be made fly-proof. The suggestion, though well received, had not materialised at the date when Old Floriana Barracks were evacuated. From S.'s history, it is seen that he sickened nine days, or less, after he left No. 8 Room, Old Floriana. Private H. H. (Case 35), the second case of the group, had been in No. 4 Room, Notre Dame, for more than two months until June 5, the same day on which Private S. left it. S.'s bed in Room 8 was No. 5, right. Private H. H.'s bed in Room 8 was No. 7 on the right. It is quite clear that S.'s illness was due to no contact with H. Whether H.'s illness had any connection with S., or Room 8, remains to be examined. H. H. came to Room 8 on the day S. left it. H. slept in a bed very close to the one S. had left, possibly the same bed. Neither bed nor room had been disinfected. S. was not ill when he left No. 8 Room. Here, apparently, are the elements of a pretty example of mediate contagion or place infection. Though S.'s case might explain H. H.'s and the other two cases, yet the converse does not hold good. Private H. H. came from No. 6 Room, Notre Dame, on June 5, to No. 8 Room, Old Floriana Barracks. His history, which follows, shows that he most probably had the disease when he came to No. 8 Room. He was admitted into hospital on June 15, and his blood reacted on the same day. If he contracted his disease in Room 8, *i.e.*, if the same cause operated in H.'s case as in S.'s, then H.'s case must be one of ten days' incubation exactly, at the extreme limit; but H. manifested almost the only symptom of his illness on June 11. Therefore the incubation period is reduced to seven days, *i.e.*, from June 5 to June 11. H. began to suffer from pains in the

knees on June 11, and had no other symptom, except rise of temperature, through the whole course of his attack. He never felt sick or lost his appetite. For a fortnight at the beginning of May he was on barrack hospital treatment for exactly the same kind of pains in his knees as caused him to go sick in June. At that time his temperature was not taken. He then was in No. 6, Notre Dame, and had been for two months. He had been an officer's servant until May 2, and, his master going on leave, he then returned to ordinary duty. He had a relapse in September. Thinking he might have been an ambulatory case, and excreting *Micrococcus melitensis* in his urine, we had it examined on several occasions, always with negative results. The history of this case makes it clear that Private H. H., when he came to Room 8, Old Floriana, was already the victim of a mild attack of Mediterranean Fever, and consequently had no connection with Private S. or Room 8.

The next case, Private K., No. 36, had been in Cottonera Hospital from May 30, to June 11, 1906, suffering from synovitis. He was admitted on that occasion from Room No. 8, Notre Dame, and therefore, so far as place is concerned, had as yet no connection with either H. or S. He had been in No. 8, Notre Dame, for two months. He came to No. 8 Room, Old Floriana, on the evening of June 11, and occupied the bed next to H.'s. He felt quite well on discharge from Cottonera, and remained so until June 18, when he had headache which continued, and he was admitted to hospital on June 21, and on the same day his blood reacted. If he got ill in No. 8, Old Floriana, he must have got his disease between June 11 and 17, on which date Room 8 was evacuated for disinfection, and all the occupants were put in tents on the roof. He must, therefore, have contracted the disease in six days, quite possible, but in his case highly improbable. His blood reacted on June 21, and the case was a mild one. Cases caused by direct inoculation, as a rule, are severe, and unless this was one, his blood would hardly have reacted within eight days of his getting the poison, and he would not have manifested symptoms within six days. The synovitis, too, from which he suffered in May, is suggestive. Though the possibility of direct inoculation in Room 8, Old Floriana, must be allowed, the history of the case makes it more than probable that Private K. contracted his disease elsewhere. We have but little evidence on which to base an opinion as to where he did contract his disease, but on asking him if he ever drank goats' milk in any form, he stoutly denied ever having done so, forgetting that he had already told us, when we examined all the men in the company as to whether they took milk, that he frequently drank egg flips, one of the ingredients of which was unboiled goats' milk; he then also stated that he drank rum and milk, a fairly common drink among soldiers in Malta.

Case No. 37, that of Private W. J. H., brother of H. H. (Case 35), must now be considered. Private W. J. H. had been employed for seven months in the Military Police, during which time he lived in 1A Block, New Floriana. Fourteen days before his admission to hospital he became an officer's servant, and on June 12 he went to live in No. 8 Room, Old Floriana. He left this room and went into a tent on the roof, as did the other occupants on June 17. He was therefore only exposed to the presumed malign influence of Room 8 for five days, from June 12 to 17. His blood, in common with those of 23 other men, contacts of the previous cases, was examined, and being found to react, and having a slight rise in temperature, he was sent to hospital on June 22 for Mediterranean Fever. In hospital he never felt ill, and did not believe there was anything the matter with him. None of the bloods of the other contacts reacted. If W. J. H. contracted his disease in No. 8 Room, he must have done so between June 12 and June 17, *i.e.*, in four days. His blood, taken on June 19, was reported to react, and again on the 23rd. As he never felt ill, it is difficult to decide when he got his disease. From June 12 to 19

(date of his first reaction) is only seven days, but all which can be granted if he contracted his disease in No. 8, Old Floriana.

These four cases have been reviewed at great length because they seemed at first to furnish a good example of contact or place infection, but careful examination of each case seems to negative that view. It is certain that H. H. did not contract his disease in Room 8, and the evidence is almost equally strong against Private K. having got ill there. Thus an apparently strong case for contact becomes a decidedly weak one. We conclude that Private S. contracted his disease when living in No. 8 Room, Old Floriana, and think that flies are a quite probable explanation of his case. We think Private H. H. contracted his disease while living in Room 4, Notre Dame, before the beginning of May, when he was an officer's servant. He denied drinking milk or eating uncooked vegetables. His occupation is suggestive. Private K. contracted his disease while living in Room No. 8, Notre Dame, and he is a possible case of milk infection by egg flips and rum and milk. Private W. J. H. was a pal of Private K., and used to knock about with him. He may have contracted his disease in the same place as Private K. Information from the colour-sergeant of his company was obtained to the effect that these three men used to frequent a public-house, paying attention to the same barmaid, and where they had egg flips. It is therefore possible that this was a common source of infection.

38. Private J., C Company, was admitted on June 25, 1906. His blood reacted next day. He came from No. 7 Room, Old Floriana Barracks, where he had lived since June 16. Up to then he had been caretaker and sole occupant of Vittoriosa Barracks from May 5. Before then he was in No. 15 Room, Notre Dame. He first felt ill with headache and faintness on June 16, when shifting his kit from Vittoriosa Barracks. He says he had been perfectly well until then. Neither his manner of life nor his diet suggest any clue to the source of his illness. At Vittoriosa he lived in the guard-room, a dark and mouldy, ill-ventilated building. Most of the ventilating shafts to the sewers are broken just above the ground level, and at times emit foul odours. He had his meals with a detachment of the 4th Rifle Brigade in Verdalla Barracks. There is no evidence of contact or of his ever having drunk goats' milk.

39. Corporal T., F Company, a relapse from September 4 to November 27, 1905. He was re-admitted on June 27 from New Floriana Barracks, where he had been for three days. Before then he had been in a tent on the roof of Old Floriana Barracks since May 5. His urine was examined to see if he was excreting *Micrococcus melitensis*. Result negative. He states he only drank milk in his tea, and that his first attack was contracted at Pembroke Camp, where he was in charge of the camp latrines.

40. Private S., A Company, was admitted June 30 from 2B Block, New Floriana, where he had been for three weeks. Before then he had been in Room 4, Old Floriana. He had had slight fever and pains at the beginning of April. These pains got worse through bathing, and he got headache about June 24. He had been in Room 4, Old Floriana, for over six weeks, and he probably was ill since April. He was an officer's servant, and had goats' milk in tea at the mess; he says he never drank it plain. We think he contracted his disease in the officer's mess before goats' milk was stopped there.

41. Lance-Corporal R., A Company, was admitted from No. 9 Room, Old Floriana, on July 9. He had been in this room for two months. He was admitted for gonorrhœa, and his disease was changed to Mediterranean Fever on August 3, 1906. He contracted gonorrhœa on June 30. He used to drink goats' milk up to the middle of June. His first symptoms of illness began on July 16, with double sciatic pains. These pains persisting, and he having fever, his blood was examined,

and found to react on August 2, 1906. There was no history of contact. He either contracted his disease where he got gonorrhœa or else when he drank milk, which he did freely until the middle of June. He also drank egg flips frequently.

42. Private B., F Company, first fell ill on August 6, 1906, with headache, backache, and giddiness. He was admitted on August 7, and his blood reacted on the same date. He had been in No. 17 Hut, Manoel, since July 11, 1906. Before then he was in a small room on the ground floor of Block B, New Floriana Barracks. He had this room to himself, and was in it since the beginning of May. In June (June 28 to July 2, 1906) he was in Cottonera Hospital, with inflammation of connective tissue, the result of scratching his arms, which had been severely bitten by sand flies. He then had slight fever, but felt perfectly fit during the interval between his discharge and readmission. He never drank goats' milk, and there is no evidence of contact. There had been no other case in any room in which he lived during the year. He used to have uncooked tomatoes for his supper frequently. He visited a brothel July 19, 1906. No venereal disease resulted.

43. Private H., September 1, 1906, relapse. (See Case 35.)

44. Private S., F Company, was admitted from Salvatore Counter-guard where he had been for the past eight months. He was admitted on September 12. The man was a signaller. The history of the case throws no light on its causation. This was the only case from the counter-guard during the year. The men in the counter-guard were living quite apart from the rest of the regiment.

The distribution by companies was as follows:—

A Company	...	6	cases.
B "	...	4	"
C "	...	9	" (including four relapses).
D "	...	4	"
E "	...	4	"
F "	...	10	cases (including one relapse), one married man and one man from Salvatore Counter-guard.
G "	...	5	cases.
H "	...	2	"

The spot map shows the barracks from which each case came.

We consider that 28 of the above cases were most probably milk infections, while all, with a few exceptions, are possible milk infections.

By barracks the distribution was:—

Old Floriana Barracks	...	14	cases.
New Floriana "	...	14	"
Notre Dame ...	...	8	"
Salvatore Counter-guard	...	1	"
Other places ...	...	7	"

A careful analysis of the cases occurring in the several companies and in the various parts of barracks was made, and we were unable to discover any particular persistence of the disease in any company or in any particular part of the barracks.

The most striking fact about the history of this regiment is that in the first six months of the year forty cases occurred, whereas, for the remaining four months of the battalion's stay in Malta, the months which usually are marked by special prevalence of Mediterranean Fever, there were only four admissions. Of these, one was a relapse, and the second was that of a case in which there is a definite history of goats' milk drinking. The first six months was the period marked by the use of goats' milk; the second represents the period in which condensed milk was in use.

Series 2.—The Cases in the Royal Army Medical Corps.

1. Private H. was admitted to Valletta Hospital for Mediterranean Fever on January 12, 1906. He had been employed as a nursing orderly on night duty in the Mediterranean Fever wards. His previous hospital entries are simple continued fever September 15 to September 22, 1905, Valletta Hospital; he then had four milk diets and 15 pints of extra milk. Again, simple continued fever October 9 to October 17, 1905, Valletta Hospital, where he had six milk diets and 11 pints of extra milk. Again, caries of dentine November 23 to November 29, 1905, Valletta Hospital, when he had five milk diets and 7 pints extra milk. Admitted for Mediterranean Fever January 12, 1906, and had been feeling unwell since January 1. This case was certainly contracted in the hospital either as a patient or when doing nursing duties. It seems to be a 1905 case, and not having examined the man personally, we think that the information available makes it possible that the case was due to hospital milk.

2. Lance-Corporal B.—Admitted January 17, 1906, for Mediterranean Fever. He was employed working the steam disinfector at Cottonera Hospital, and is believed to have contracted the disease through handling soiled bed linen. We know nothing about his drinking milk beyond the fact that goats' milk was then in use at the hospital. From what we know, infected clothing seems the most probable source of his illness.

3. Private Y.—Admitted January 22, 1906, for Mediterranean Fever. He had been detachment mess orderly for the Royal Army Medical Corps, employed at Cottonera Hospital, for three months before he got ill. He is noted as being habitually careless. There is no evidence of contact with Mediterranean Fever patients. Goats' milk was in use in detachment mess. In the absence of other information, he is a possible case of milk infection.

4. Corporal W.—Admitted February 15, 1906. First felt ill, February 1, 1906. Employed at Forrest Hospital since December 8, 1905, in charge of disinfection duties. Is supposed to have contracted his disease through handling infected clothing. Nothing known about his drinking milk. Goats' milk was then used at Forrest Hospital.

5. Private P.—Admitted February 15, 1906. Has had pains since January 15, but has never felt really well since attack of simple continued fever in July and August, 1905. He had some teeth extracted in December last, and was then a patient in hospital from November 28 to December 3, 1905, and had two days' plain milk diet when teeth were extracted, otherwise states he only had milk in tea. He was employed at Valletta as nursing orderly in Mediterranean Fever wards, and did night duty, and had to handle vessels containing stools and urine of Mediterranean Fever patients. Said he was always very careful about personal disinfection. This man was evidently ill since January 1, and may possibly be a milk infection. The case was contracted in Valletta Hospital.

6. Private L.—Admitted February 28, 1906, after feeling ill for three days. Had simple continued fever in August, 1905. Was employed as nursing orderly in Mediterranean Fever ward at Valletta. This man states that he frequently drank goats' milk with soda water. He used to get it at the canteen. Does not know whether boiled or not. This man is a quite possible milk infection.

7. Lance-Corporal P.—Admitted March 12. Had been employed in the Mediterranean Fever Commission laboratory when experimental work was being tried there with infected dust. He almost certainly was a case of laboratory infection. He drank goats' milk in tea only. He thinks infected dust was the cause of his illness.

8. Private B.—Admitted April 1. Was employed in enteric and Mediterranean Fever wards, Valletta. Had no previous admissions in Malta. Went for duty to Imtarfa on March 17, and first felt ill on March 29. Had much handling of bedding and bed-pans and urinals of Mediterranean Fever cases; was in the habit of drinking goats' milk unboiled freely at the house of a civilian friend, an almost daily habit until the time of illness. This is a very possible case of milk infection.

9. Private C.—Admitted April 3, 1906, had no previous admissions. Employed on general duty in Cottonera Hospital. Had little or no direct contact with Mediterranean Fever cases. This man said that he frequently took both boiled and unboiled goats' milk, and that he took it in large quantities. He also informed us that many Royal Army Medical Corps men did the same. He attributed his illness to a wound of the hand caused by a splinter when scrubbing the floor in No. 5 Ward, Cottonera Hospital. He often took tea in Valletta tea shops. This is a quite possible case of milk infection.

10. Corporal F.—Admitted April 8, 1906, after feeling ill for four days. Employed as store-keeper, and had much handling of infected linen, etc. Was seldom or never in the Mediterranean Fever wards. This man states that he never drank goats' milk even in tea. Milk seems out of the question in this case.

11. Corporal B.—Admitted May 1, 1906, after feeling ill for three weeks. Has no previous hospital entries. Was employed at Forrest Hospital as assistant ward master, pack store keeper, and in charge of bedding. He had to steep the linen of patients in carbolic lotion before its removal to Cottonera Hospital for steam disinfection, but had not much of that class of work at Forrest Hospital, and little or no contact with Mediterranean Fever cases. Drank soda water and goats' milk daily. This man's wife got Mediterranean Fever shortly after her husband's admission. They lived in quarters (the caretaker's house, Spinola Battery), some distance from Forrest Hospital. Mrs. B. states that she, too, drank soda water and goats' milk, but that she always boiled the milk for her husband and herself. There are excellent grounds for believing that this house was not very carefully managed, and though her statement may be in the main true, as she is careless in other matters she is not likely to have been careful in the matter of milk boiling. These cases are both possible cases of milk infection; indeed, we believe milk to be the most likely source.

12. Private M.—Admitted for Mediterranean Fever on May 9. He had been employed in the general duty section at Valletta Hospital, and just before his admission was employed window cleaning in the long ward, Valletta Hospital, at the time a general disinfection of this ward took place. He attributes his illness to this cause. The medical history of the case, however, suggests that this cause had nothing to do with the case, and it is quite likely that he contracted his disease in 1905. He had offered himself for protective inoculation, and on examining his blood before this was done it was found to give a positive reaction to *Micrococcus melitensis*. This was on April 25, 1906. In consequence of the reaction he was not inoculated. His medical history is as follows: Sprain (right ankle), December 20 to December 23, 1905, no definite cause; sprain (right knee), February 21 to

February 26, 1906. Rheumatism, March 24 to March 27, 1906; rheumatism, March 28 to March 29, 1906. Colic, April 28 to April 30, 1906. He says he only had goats' milk in tea, and also in hospital as a diet when he had colic and on the previous occasions. He had no direct contact with patients, but had to clean the seats of No. 37 latrine and oil the urinal. It is difficult to believe that the dusting of the windows in the long ward in April had anything to say to this man's illness. The source of infection is not known, but it is a possible milk infection.

13. Private B.—Admitted on May 13, after three days' illness, and had no previous illness in Malta. Has been lunatic attendant at Cottonera Hospital since arrival in Malta (October 3, 1904). He had cut the hair of a few patients who had Mediterranean Fever, the last time he did so being April 25, 1906. He slept in a bunk by himself. Stated he only had goats' milk in his tea, and about twice a month with porridge; the last time he had porridge and milk was about April 21. He thinks he contracted his disease through cutting the hair of Mediterranean Fever patients. This is a possible milk infection.

14. Corporal G.—Admitted May 13, 1906, after feeling really ill since the middle of April, but had no previous admission. He was clerk in the office at Cottonera Hospital. He never went into the Mediterranean Fever wards, but used to send off the blood pipettes containing the blood of cases for examination. He stated that sometimes a tube was open, and that blood may have got on his hands. He slept in a bunk by himself, and had his meals at the sergeants' mess, where each man puts the milk into his own tea, *i.e.*, milk and tea not in bulk. He stated that he had never taken goats' milk neat. He used to have tea and coffee in a tea-house, Valletta, occasionally. Goats' milk is as probable a source as any other in this case.

15. Private S.—Admitted May 25, 1906, after feeling ill for five days. Employed at Valletta Hospital in general duty section. His principal duties were spraying the rooms and beds of patients who had been removed to hospital with Mediterranean Fever, and superintending the milking of the goats at Valetta Hospital. M. (case 12) had slept in the bed next to his bed, but not for a fortnight before M. went sick. Interval between April 26 to May 25. Says he only had goats' milk in tea in hospital, but used to have egg flips freely on Saturday nights; last occasion May 12, 1906. These egg flips were got at the Round House, Strada Reale, and contained goats' milk. This is a possible case of infection through milk.

16. Private J.—Admitted June 19, 1906. Employed as sergeants' mess waiter at Valletta Hospital, and had been ill since June 11, 1906. He had milk in tea until May 21, and drank unboiled goats' milk about a fortnight before that date. He had access to milk in the sergeants' mess. There is no history of contact, and no previous illness in Malta.

17. Lance-Corporal J.—Admitted September 2, but ill since August 1, or probably longer. He worked all the season in the Commission laboratory, and had to handle many infected animals. He had been twice inoculated against Mediterranean Fever. Milk in tea only. Is an almost certain laboratory infection.

18. Private B.—Had been in Gozo for two years and nine months, before which period he had had simple continued fever for 22 days in Valletta Hospital (October 5 to October 27, 1903), on which occasion he was ill for three weeks before he went sick. He returned from Gozo on March 19, 1906. He was twice inoculated against Mediterranean Fever this year, on April 26 and on May 10, 1906. He was a patient in Valletta Hospital from May 30 to June 6 with dyspepsia, and again with debility September 3 to September 15, and on September 16 disease was changed to Mediterranean Fever. He had been feeling ill since May 15 with pains in different parts of his body and limbs. His duties after his return from Gozo were four days' gate duty, then washing floors and windows and woodwork of 20A Ward after it had been disinfected and colourwashed in April, after which he was taking bed cots

to pieces, and oiling and cleaning them. This work took about 14 days. After this, did 28 days' night duty in Mediterranean Fever ward. Next had an admission to hospital as above. When discharged had 14 days on gate duty; after that did general duty fatigues up to the time he went sick, on account of increasing pains. This man states that he only drank milk in his tea. The beginning of his illness is quite uncertain. He may possibly have had a mild attack of Malta Fever before he went to Gozo, and he seems to have got his present attack about May this year. It is a possible milk case.

From the histories of the above cases it is seen that their employments were as follows:—

Five men were employed as nurses of Mediterranean Fever patients. Two were in charge of the steam disinfector for the disinfection of linen, bedding, clothing, etc., of Mediterranean Fever patients. One was the detachment mess orderly at Valletta Hospital, and had no contact with Mediterranean Fever cases. Two were attendants in the laboratory of the Mediterranean Fever Commission. Three men were employed in the general duty section of the Royal Army Medical Corps, and had very little to do with Mediterranean Fever cases directly or indirectly. One man was hospital store-keeper, and had to handle infected linen. One was assistant ward master at Forrest Hospital; he had little to do with Mediterranean Fever cases. One was a lunatic attendant (no contact). One was a clerk in the office at Cottonera Hospital (no contact). One man was sergeants' mess waiter (no contact).

Of the whole series, in three cases only is it possible to exclude goats' milk as a possible factor in the causation of the disease. Six cases in our opinion were most probably due to milk infection.

Series 3.—*Hospital Cases.*

Of cases which we think were contracted in hospital, other than men of the Royal Army Medical Corps, there are 23, or 14·5 per cent. of all the cases to the end of November. None of these presumed hospital infections took place later than June 11, and the case diagnosed on that date was that of Quartermaster-Sergeant W., Royal Engineers, who had been in Valletta Hospital since February 27, with enteric fever. He was a married man and lived in the married quarters, St. George's Barracks. His wife did not contract the disease. He had no contact with Mediterranean Fever patients. We think his illness was most probably due to milk infection while a patient in hospital. The last case before Quartermaster-Sergeant W.'s was admitted on May 30. It is thus evident that all the possible hospital infections during the year occurred within a period of 15 days after the use of goats' milk was stopped in the military hospitals.

The history of the remaining 22 cases is given below :—

1. Private L., Royal West Kent Regiment, was invalided before we arrived in Malta. He was admitted from Room 4, Block C, New Floriana Barracks, the only case during the year from the room, on November 11, 1905, to Cottonera Hospital, with simple continued fever, and was transferred to Citta Vecchia on December 24, 1905. He was on milk at Cottonera from November 14 to the end of the month, and at Citta Vecchia he had milk from January 2. His blood reacted to the *Micrococcus melitensis* on January 14, 21 days after his transfer from Cottonera. He seems to have contracted his disease at Citta Vecchia, and is a possible case of milk infection.

2. Gunner P. was admitted into hospital on January 8, 1906, from Hut 30, Tigne, from which hut there were no other cases during the year. He was admitted with gonorrhœa. His disease was changed to Mediterranean Fever on January 30, 1906, and his blood reacted on January 31. He had been feeling ill for a week. He had two days on milk on his admission. He stated that he often drank soda and milk at different houses in Sliema and Valletta.

3. Bombardier S., Royal Garrison Artillery, had been in Tigne, Block A, Room 1, and from there was admitted to Valletta Hospital, with psoriasis, on October 17 to December 6, 1905. From Valletta he was transferred to Citta Vecchia Sanatorium from December 7 to February 8, 1906. He was diagnosed as Mediterranean Fever on February 10, 1906, after feeling ill for four days. His blood reacted on February 10. This was his first illness in Malta. The disease was contracted at Citta Vecchia, where he had milk (extra) every day from his admission. He had possible contact with convalescent patients in Citta Vecchia, but no direct relations with them.

4. Private M., 1st Royal West Kent. The history is curious. Private M. was in Cottonera Hospital from August 29 to November 28, 1905, with gonorrhœa. On discharge from hospital, he went to No. 5 Hut, Notre Dame, where he lived for five days, and then embarked for England, time expired, on December 3, 1905. He remained in England, perfectly well, until February 10, 1906, and then, having rejoined, embarked for Malta, where he arrived on February 19, 1906. When marching up to barracks from the ship, he got drenched with rain (February 19, 1906, was a day of heavy rainfall—1''·943—for Malta), and next day he felt stiff and ill, with pain in the left shoulder and a feeling of malaise. This pain got worse, and on February 27 he was admitted to Valletta Hospital, where he was found to have fever. His blood reacted on March 4, 13 days after he reached Malta. The time is long enough for a man to get Malta Fever, but this man was perfectly certain that on February 20 he had all the symptoms for which he was admitted to hospital on February 27. He had a first-class memory, and told all the dates without pause, which were subsequently verified by reference to official documents. Where or when did he contract his disease? We think he contracted it in Cottonera Hospital before his departure for England, otherwise he began to manifest the symptoms of it on the day after his return to Malta.

5. Private P., 1st Royal West Kent, was admitted to Valletta Hospital, after feeling ill for five days, on March 12, 1906. He had been in Room 33, Old Floriana Barracks, for 89 days, before which he had been in Valletta Hospital with gonorrhœa, and had had milk during that admission. He is a probable hospital case, otherwise he may have contracted his disease when he got his gonorrhœa.

6. Gunner B. This man was stationed in Fort Ricasoli since his arrival in Malta. He had been in Room 2 for four months, and was the only case from the room this year. He had been in Cottonera Hospital from February 15 to February 23, 1906, with an abscess in the hand and, on discharge, returned to Ricasoli, which he hardly ever left in the interval between discharge and

readmission, as he "felt weak." He got leg pains and headache on March 16, and was admitted with Mediterranean Fever on March 21, and his blood reacted on March 25. This man used to frequent both public-houses and tea-shops before his first admission to Cottonera. It is probable that he contracted his disease in Cottonera Hospital, or in some of his Valletta haunts. He had several days' milk diet in Cottonera on his first admission, and he also used to have tea frequently in Valletta tea-shops.

7. Trumpeter S., 100th Company, Royal Garrison Artillery, was admitted into hospital, March 28, 1906, and was found to be suffering from Mediterranean Fever. Blood reacted April 2, 1906. He had been feeling ill, *i.e.*, tired and had headache frequently, and pains in arms and legs, and poor appetite, for about two months before his admission, that is to say, he felt ill from the first week in February. He had been in Cottonera Hospital—November 16 to December 5, 1905—with gonorrhœa, and had had milk in hospital. He said he had never had food out of barracks, and then only barrack rations and tea (condensed milk). He ate no uncooked vegetables or fruit. He spent a few days in No. 11 Room, Ricasoli, before his admission, from which room Bombardier C. was admitted for Mediterranean Fever on March 1, 1906. Trumpeter S. obviously did not contract his disease in No. 11 Room, as he had been feeling ill a long time before he went into it. If he contracted his disease in Ricasoli it was in Room No. 6, where he lived from the time of his discharge from Cottonera until his readmission for Mediterranean Fever.

It may be remarked here that five cases out of eight, admitted for Mediterranean Fever in 1906, had all been in Cottonera Hospital at or about the same time, suffering from other complaints, and were readmitted with fever within two months of their discharge, *i.e.*, the following cases:—

Gunner R.—Cottonera Hospital, for soft chancre, September 26 to December 9, 1905, during which time he had some fever, but his blood did not react. He was readmitted with Mediterranean Fever January 21, 1906. Interval between discharge and readmission, 43 days.

Gunner L.—Cottonera Hospital, for inflammation of lymph glands, October 22 to November 20, 1905, was then transferred to Citta Vecchia Sanatorium from November 21 to December 19, 1905, and was readmitted for Mediterranean Fever January 26, 1906. Interval between discharge and readmission, 37 days.

Gunner D.—Cottonera Hospital, for soft chancre, October 31 to November 28, 1905, and was readmitted January 17, 1906, with Mediterranean Fever. Interval between discharge and readmission, 50 days.

Gunner K.—Cottonera Hospital, for gonorrhœa, November 21 to December 5, 1905, and was readmitted for gonorrhœa January 15, 1906, and his blood reacted to *Micrococcus melitensis* January 18, 1906. Interval, 41 days.

Trumpeter S.—Cottonera Hospital, for gonorrhœa, from November 16 to December 5, 1905, felt unwell since the first week in January. Interval between time he was discharged from hospital and time he began to feel ill, about 26 days.

The sequence of the cases is suggestive of a possible hospital source, but these cases have not been included in the hospital list, as we have not sufficient facts on which to base a definite opinion.

8. Gunner N., 96th Company, Royal Garrison Artillery, had been in St. James' Cavalier Barracks, Room No. 4, for three months. No other case from this room. He had been in Valletta Hospital with catarrhal jaundice from February 17 to March 5, 1906, during which time he was on milk diet. He began to feel ill about March 22, and was readmitted to Valletta Hospital on March 28, and his blood reacted on April 6, 1906. There is no evidence of contact. The disease was most probably contracted in Valletta Hospital.

9. Private R., 4th Rifle Brigade, had been in St. George's Barracks, Room No. 6, B Block, since arrival in Malta. His medical history is as follows: Myopia (Forrest Hospital), January 26 to February 5, 1906. Myopia (Valletta Hospital), February 5 to March 2, 1906. Readmitted (Valletta Hospital), for myopia on April 4, 1906, and about 18th began to feel ill, and blood reacted on April 23, 1906. He used to drink goats' milk when band cook, but he ceased to be employed as a cook on January 26, 1906. He had milk in Forrest Hospital from January 26 to February 5, 1906. The disease was probably contracted at Forrest Hospital.

10. Lance-Sergeant C., 2nd Essex, was at Ghain Tuffieha, August, September, and October, 1905, then for the next three weeks at Imtarfa, and for the next three weeks at Pembroke Camp, then at Mellieha Camp, and there reported sick with gonorrhœa, and was tranferred to Valletta Hospital December 21, 1905, to March 17, 1906. He was then transferred to Imtarfa to attend hospital. He was discharged to duty on March 20, 1906. He was readmitted to Imtarfa on April 6 with fever, and was transferred to Valletta on April 20, 1906. A week before he left Valletta, during his first admission, he had headache, and felt out of sorts. He was on milk for a month after his admission, and his disease was most probably contracted in Valletta Hospital. He was in contact with Mediterranean Fever cases in the wards, but had no direct relation with the cases. He had nothing to do with the patients.

11. Gunner S.—Admitted from a tent in Fort Ricasoli. Medical history: gonorrhœa February 1 to April 7, 1906, Cottonera Hospital; transferred to Imtarfa Hospital April 7, 1906, where he remained until he was sent back to Valletta Hospital on April 20, 1906. He had fever all the time he was in Imtarfa Hospital. He stated that he had been in bed with fever at Cottonera Hospital for a few days, about March 3, 1906. He had milk at Cottonera from February 2 to 4, from February 7 to 12, and from February 21 to 24. He was feeling out of sorts about a fortnight before he left Cottonera Hospital. Only had contact by meeting convalescent cases in the library at Cottonera; no known contact outside.

12. Private R., Royal West Kent, from Room No. 3, Old Floriana Barracks. Medical History: inflammation of ear, Valletta Hospital, March 15 to March 27, 1906; gonorrhœa, March 29 to April 9, 1906. He first felt ill on April 14, and was admitted April 16, and his blood reacted on April 18. He was in Room No. 3, Old Floriana Barracks, for five days only when he felt ill. He was on milk in Cottonera Hospital from March 30 to April 2, 1906. He owned to drinking goats' milk at Pembroke Camp on the day before his admission. He denied having ever been in a brothel, but had had gonorrhœa. Private P. (Case 5) came from Room No. 3, Floriana (see above). He was admitted March 12, 1906, at which time R. was in hospital; R. almost certainly contracted his disease at Cottonera Hospital, and is a possible milk infection, or he contracted his disease at the same time as his gonorrhœa.

13. Gunner S.—Was admitted from Hut No. 19, Tigne, but up to four days before he was in Hut No. 31, and there was no other case from either during the year. He had been in Valletta Hospital with psoriasis from April 23 to March 16, 1906, and was transferred to Citta Vecchia with the same disease from March 17 to April 2, 1906. From day of his discharge, he did officers' mess fatigues. He felt ill on April 13, 1906, and was admitted with Mediterranean Fever on April 14, 1906. There is no evidence of contact. He was on ordinary diet and one pint of milk at Valletta, and on the same at Citta Vecchia, where his disease was certainly contracted.

14. Gunner K.—Gonorrhœa, from March 4 to March 20, 1906, in Valletta Hospital, and was transferred with the same disease to Cottonera Hospital on March 21, and he began to feel ill on April 9. Disease was changed to Mediterranean Fever on April 16. He had milk diet and porridge and milk up to date of

transfer. He came originally from Room No. 18, Upper St. Elmo. There is no evidence of contact. Disease was contracted in Valletta Hospital.

15. Lance-Corporal B., Army Service Corps, in Valletta Hospital, for soft chancre, January 22 to March 16, 1906, then discharged to attend hospital. He was not allowed out of barracks (Old Laboratory) except to attend hospital. When attending on April 11, 1906, he began to feel out of sorts, and on April 25, 1906, was found to have a temperature, and was then admitted. His blood reacted on April 27. At the time he left hospital, he was on ordinary diet and a pint of milk. He had no contact in barracks and no direct contact in 20B Ward, Valletta. This is a hospital case.

16. Gunner B., married man, wife and four children all well, and none of their bloods reacted. He came from No. 5, Married Quarters, Vicolo Tigne. The medical history is a curious one. Simple continued fever from November 1 to November 5, 1902. Simple continued fever from October 1 to October 8, 1905. Simple continued fever from October 14 to November 3, 1905 (Valletta Hospital). Gout from January 25 to February 5, 1906 (Valletta Hospital). Gout from March 17 to April 16, 1906. He developed Mediterranean Fever at Citta Vecchia on May 4, 1906. His blood reacted May 6, 1906. He was not in contact with Mediterranean Fever cases either at home or in hospital. Condensed milk only is used in his home. He had milk both at Valletta and Citta Vecchia. This case probably dates from October 14, 1905, and is most likely a hospital infection, and milk as the agent cannot be excluded.

17. Gunner M.—Arrived in Malta November 10, 1905, and had been stationed in Valletta since. Medical history: Cottonera Hospital, gonorrhœa from December 2 to December 15, 1905. Valletta, balanitis from January 15 to January 19, 1906. Gastritis and gonorrhœa from February 6 to March 21, 1906, in Cottonera Hospital. Gonorrhœa from March 22 to April 10, 1906, and operation for varicocele. Was admitted from a tent in Upper St. Elmo Barracks on May 6, 1906, after feeling ill for a fortnight with headache and sore throat. He had not left barracks, except on duty, since last discharge from Cottonera Hospital. He was on milk during his last admission to Cottonera Hospital. There is no evidence of contact. This man contracted his disease in Cottonera Hospital, and is a possible milk infection. Gonorrhœa was not contracted in Malta.

18. Private M., 4th Rifle Brigade.—Was in St. George's Barracks, but has been almost constantly in hospital since his arrival in Malta. He got a blow on the left knee when doing transport work, which resulted in synovitis. From December 30, 1905, to January 6, 1906, he was in Forrest Hospital with synovitis. He was in Valletta Hospital from February 2 to March 26, 1906, with synovitis, and was transferred to Citta Vecchia Sanatorium from March 27 to May 8, 1906, and on May 9 Mediterranean Fever was diagnosed. This man probably got his disease at Citta Vecchia, where he was on milk for over a fortnight before he began to feel ill. There is no evidence of contact either in barracks or hospital.

19. Gunner B. was quartered in St. James' Cavalier until February, then came to Upper St. Elmo. He had the following medical history: gonorrhœa, February 21 to March 14, 1906, Valletta Hospital; tonsilitis, March 25 to March 27, 1906, Valletta Hospital; tonsilitis, March 28 to April 2, 1906, Cottonera Hospital. About May 8, 1906, his present illness began with headache and pains in limbs, and he was readmitted to Cottonera with gonorrhœa. He was transferred to Valletta Hospital on May 15, 1906, as a case of Mediterranean Fever. He was in a brothel on April 29. He was on milk diet during the time he was in Valletta and Cottonera Hospitals for tonsilitis, and again at Cottonera on admission of May 9, 1906. For contact in barracks, see Case 20 below. We think this man contracted his disease either in Valletta or Cottonera Hospital. In any case, it is a possible milk infection.

20. Gunner R. was in Upper St. Elmo 1½ years. Came from Room 5. Had been in Cottonera Hospital with rheumatic fever, March 23 to April 23, 1906. His blood gave negative reaction to *Micrococcus melitensis* on March 28, 1906. During that admission he was on milk from March 23 to April 13, 1906. After discharge, he did signalling. He felt ill, and had a swollen right ankle on May 14, and was readmitted to Cottonera on May 15, and was transferred to Valletta Hospital with Mediterranean Fever on May 20, 1906. Blood reacted on May 18. Gunner B. (Case 19), who was admitted May 9, 1906, came from the same room, but from a bed at the far end of the room, and on the opposite side. It was a large room with only six other men in it. Their bloods were examined, but all gave negative reactions. We think that the disease was contracted in Cottonera Hospital, and is a possible milk infection.

21. Sapper F.—Simple continued fever from June 19 to June 27, 1905; simple continued fever from July 7 to July 13, 1905; fissure of anus from October 19 to November 16, 1905; chronic dysentery from January 23 to March 26, 1906, and was transferred to the Sanatorium at Citta Vecchia from March 27 to April 9, 1906. He was again in Cottonera Hospital, with fissure of anus, from April 16 to May 2, 1906. After discharge from Cottonera Hospital, he went to St. Francis Ravelin Barracks, Room No. 3 (only case from this room during the year), and there did light duty, although he was not feeling well, until May 23, 1906, when he felt very ill. He was admitted for Mediterranean Fever on May 30, 1906. He was on plain milk diet for first seven days of his previous admission to Cottonera Hospital, just a month from the time he felt really ill, and which illness proved to be Mediterranean Fever. If this man was not a Mediterranean Fever case from 1905, he most probably contracted it at Cottonera Hospital. During his last stay in Cottonera Hospital there were no Mediterranean Fever patients in it. Milk in Cottonera Hospital is a possible cause. The bloods of 25 men from his barrack room were examined, and that of two men gave a partial reaction (1 in 10). Neither of them were or have been ill. Their urines were also examined, with negative results.

22. Gunner B. was admitted into Valletta Hospital on May 2, 1906, for appendicitis. He was in the surgical ward, and had no contact with Mediterranean Fever cases. He had his appendix removed on May 22. On May 31 he had headache and pains in both legs, and on June 1st, he was sent to the Mediterranean Fever wards. Before the admission for appendicitis he had been in Valletta Hospital from March 26 to April 24 with a previous attack of the same complaint, and in the interval between his discharge and readmission he had been in the guard-room at Tigne Barracks. There is no evidence of contact either in or out of hospital. He was on milk during the whole time of his last admission in Valletta Hospital up to May 21.

Valletta Hospital was taken into use for isolating Mediterranean Fever cases on May 1, 1906, after which date all Mediterranean Fever cases from all parts of the island were sent there for treatment. One possible source of infection, *i.e.*, contact with patients in hospital, ended on the above-mentioned date, for Cottonera, Forrest and Imtarfa Hospitals. Though this source of danger, *i.e.*, handling bed-pans and urinals containing the excreta of Mediterranean Fever patients and their soiled linen, ceased for the Royal Army Medical Corps orderlies at Cottonera, Forrest, and Imtarfa Hospitals, yet it still remained for the orderlies employed at Valletta Hospital. Notwithstanding this fact, the orderlies of the Royal Army Medical

Corps at Valletta enjoyed the same freedom from attack, for the rest of the year, as the orderlies in the other hospitals. There were two apparent exceptions, but, we believe with reason, only apparent and not real exceptions. See Cases 17 and 18 of the Royal Army Medical Corps list. We think the immunity from attack of the Royal Army Medical Corps orderlies at Valletta Hospital was due to the change from goats' milk, as the hospital supply, to condensed milk.

While fully awake to the probability of other paths of infection than milk, we think that occasional lapses from effective sterilisation are a reasonable explanation of the occurrence of cases of Mediterranean Fever among patients, who were or had recently been in hospital suffering from other complaints.

Another possible explanation for some of these cases is infection by flies. When we first visited Valletta Hospital, we noticed numbers of flies on helpless patients, just as they are often observed on enteric cases. This possible source of hospital infection was greatly lessened at Valletta, about the end of June or the middle of July, by the fact that then both the barrack rooms of the men of the Royal Army Medical Corps and the Mediterranean Fever wards were protected from flies by using wire net doors and by fixing mosquito net frames in all the windows. This measure, though perhaps not required for the purpose for which it was originally designed, was most efficient in the exclusion of flies, both from the barrack rooms and wards.

An examination of the diet sheets of patients in Valletta Hospital during the year 1905 seems to afford confirmatory evidence that milk in hospitals has been a causative factor of Mediterranean Fever.

Examination of the Diet Sheets of Patients in Valletta Hospital during 1905.—The diet sheets of patients in Valletta Hospital, during 1905, were examined to see whether there was greater prevalence of Mediterranean Fever among men who had taken milk diet, or extra milk, while in hospital for disease other than Mediterranean Fever, when compared with men who had been in hospital under similar conditions, but without having had milk diet or extra milk. Two thousand and thirty-one diet sheets were examined, of which 190 were found to be useless for the purpose of the enquiry and therefore were rejected. The 190 sheets were those of men who fall under three heads: I. Patients who were admitted into Valletta Hospital for Mediterranean Fever, without having had any previous admission for any other disease during the year; II. Patients who were transferred to Valletta Hospital from other hospitals, and whose previous history is unknown; III. Patients (a few) who had no record of their disease on the diet sheet. After subtracting these 190 from the original total, there remain 1841 diet sheets for examination. Of these, 1460 belong to men who had been in hospital one or more times during the year; all had received either milk diet or extra milk, or both, while the

remaining 381 are those of men who had also been in hospital one or more times during the year, but who had received no milk in hospital, except in tea. Of the 1841 diet sheets, 176 are those of men who were readmitted for Mediterranean Fever, and all of whom had previous admissions during the year for other diseases. Of these 176 men, 172 had had milk in hospital before their admission for Mediterranean Fever; the remaining four men had no milk while in hospital, except in tea. From these figures it appears that 1460 patients who had taken milk when in hospital suffering from diseases other than Mediterranean Fever subsequently gave 172 cases of that disease, while 381 patients who had no milk in hospital subsequently gave four cases. The ratio for the larger group is 11·8 per cent., for the smaller group 1·05 per cent. The 172 patients who were in hospital for one or more diseases within the year and were admitted later for Mediterranean Fever have been classed under three headings. Of the following three tables, No. XI shows the quantity of milk, in pints, which each patient had in hospital, before his readmission for Mediterranean Fever. No. XII the time, in weeks, each patient had milk in hospital, before his readmission for Mediterranean Fever, and No. XIII the interval, in weeks, between the last day on which a patient had milk in hospital and the date of his readmission for Mediteranean Fever.

Table XI.

Quantity of milk in pints	A. Under 5, smallest quantity 3.	B. Over 5, under 10.	C. Over 10, under 20.	D. Over 20, under 40.	E. Over 40, under 60.	F. 60 and over.	Total.
Number of patients...	10	16	31	50	23	42	172
Percentage of patients in each class	5·8	9·3	18·0	29·1	13·4	24·4	100

Table XII.—Length of Time in Weeks during which Patients who later were readmitted for Mediterranean Fever had Milk in Hospital.

Time	A. 1 to 7 days.	B. Over 1, under 2 weeks.	C. Over 2, under 3 weeks.	D. Over 3, under 4 weeks.	E. Over 4, under 5 weeks.	F. Over 5, under 6 weeks.	G. Over 6 weeks.	Total.
Number of patients ...	63	34	28	20	10	4	13	172
Percentage of patients	36·6	19·8	16·3	11·6	5·8	2·3	7·6	100

Table XIII.—Interval in Weeks between Date on which Patient had Last Milk and Date of readmission for Mediterranean Fever.

Time	A. Under 1 week.	B. Under 2 weeks.	C. Under 3 weeks.	D. Under 4 weeks.	E. Under 5 weeks.	F. Under 6 weeks.	G. Under 7 weeks.	H. Under 8 weeks.	I. Under 9 weeks.	K. Under 10 weeks.	L. Under 11 weeks.	M. Under 12 weeks.	N. Up to 40 days.	Over 3 months.	Total.
Number of patients	17*	9	9	15	15	25	13	12	8	3	9	4	8	25	172
Percentage of patients	9·9	5·2	5·2	8·7	8·7	14·6	7·6	6·9	4·7	1·7	5·2	2·3	4·7	14·6	100

* The following six cases, which were those of patients who were taking milk when the diagnosis of Mediterranean Fever was made, have been included in Table XIII—A:—

1. Case No. 38.—Gunner S., 4th Royal Garrison Artillery, was admitted January 9, 1905, with gonorrhœa, and when in hospital with that disease he was diagnosed as a case of Mediterranean Fever on March 8, 1905. He had milk in January, and all through February.

2. Case No. 43.—Private V., admitted August 22, 1905, with enteric fever, during the course of which he was diagnosed, October 8, 1905, as a case in which Mediterranean Fever had supervened. He had milk all through his illness.

3. Case No. 107.—Private G., admitted May 14, 1905, for gonorrhœa. On July 1, 1905, he was diagnosed as Mediterranean Fever. He had had milk during the whole period in hospital.

4. Case No. 113.—Private O., 1st Rifle Brigade, admitted for gonorrhœa on May 2, 1905, and was diagnosed as Mediterranean Fever on June 16, 1905. He had 21 pints of milk in May, and was on milk all through June.

5. Case No. 119.—Private W., admitted May 30, 1905, for enteric fever, and was diagnosed July 16, 1905, as Mediterranean Fever. He had been on milk from first date.

6. Case No. 161.—Acting Bombardier L., Royal Garrison Artillery, admitted September 11, 1905, for liver abscess, and was diagnosed Mediterranean Fever November 10, 1905. He had milk from first date.

The 381 men who had been in hospital, but had no milk, are divided into two groups, men who were not readmitted for Mediterranean Fever, and men who were. In the first group there were 377 men; in the latter group there were four.

Table XIV shows the time, in weeks, spent in hospital by all the men who were not readmitted for Mediterranean Fever.

Table XIV.

Time in weeks...	1 and over.	2 and over.	3 and over.	4 and over.	5 and over.	6 and over.	7 and over.	8 and over.	9 and over.	10 and over.	11 and over.	12 and over.	Total.
Number of men	146	101	44	35	13	8	5	8	2	1	1	13	377
Percentage of men	39·4	26·5	11·5	9·2	3·4	2·1	1·3	2·1	0·6	0·3	0·3	3·4	100

The four men who had been in hospital during the year, but who had no milk, and were admitted during the same year with Mediterranean Fever, had the following history:—

1. Private S. was admitted December 27, 1904, to February 6, 1905, with synovitis of right knee. Had no milk in hospital. He was readmitted on November 8, 1905, with Mediterranean Fever. Interval, in weeks, between discharge from hospital and readmission, 39.

2. Private W. was admitted from December 21, 1904, to January 6, 1905, with rheumatism. He had no milk in hospital. He was readmitted for Mediterranean Fever on May 21, 1905. Interval, in weeks, between discharge and readmission, 19.

3. Gunner R. W. was admitted from February 10 to March 22, 1905, for soft chancre. He had no milk in hospital. He was readmitted November 1, 1905, with Mediterranean Fever. Interval, in weeks, between discharge and readmission, 32.

4. Private W., Royal Army Medical Corps, was admitted from June 4 to June 7, 1905, with contusion. He had no milk in hospital. He was readmitted August 7, 1905, with Mediterranean Fever. Interval, in weeks, between discharge and readmission, 8. (This man was sergeants' mess waiter.)

From the above history it appears extremely unlikely that hospital influence had any causal relation to the subsequent admission of any of these four men.

We think that the deductions which may be drawn from this examination are:—

1. There is evidence that the probability of a patient being subsequently admitted to hospital for Mediterranean Fever bears a direct relation to the quantity of milk he has had in hospital, and

increases with an increase of the milk he had had when in hospital (see Table XI).

2. That there is little relation between the actual length of time any patient was on milk in hospital and the probability of his subsequent readmission for Mediterranean Fever. The relation is rather one of quantity of milk than of time.

3. That over 80 per cent. of men who were readmitted with Mediterranean Fever were readmitted within 90 days from the date on which they last had milk in hospital, while over 50 per cent. of these subsequent readmissions took place within six weeks from the date on which the patient last had milk.

4. That men who have been on milk in hospitals for longer or shorter periods show over 10 times the incidence as compared with men who have not had milk during their previous stay in hospital when suffering from other complaints. It is to be noted further that milk is used in hospitals in much greater quantities during the hot weather months than during the cold, that is to say, a larger quantity of a presumably infected article is then used.

Series 4.—*Other Cases of Possible Milk Infections.*

1. Gunner S., No. 1 Company, Royal Garrison Artillery.—Admitted December 31, 1905, to January 18, 1906, from Fort Benjemma, where he had been for eight months. He stated that, before he got ill, he frequently drank egg flip, and sometimes had goats' milk and soda water. There was no history of contact in this case.

2. Private E., 1st Rifle Brigade. Admitted December 31, 1905, to January 21, 1906, from St. Andrew's Barracks, J block. There was no other case from the room during the year. He stated that he drank goats' milk freely, as he said he thought it did him good. He was admitted for rheumatism, and his disease was changed on January 5, 1906.

3. Private L., 1st Lancashire Fusiliers.—This man came from Room No. 3, Lower St. Elmo. He was admitted on January 1, 1906, from Mellieha Camp. He had two previous admissions for simple continued fever in 1905, namely, from June 12 to June 17, 1905; and again from November 22 to November 27, 1905. He had milk in Cottonera Hospital during his last admission, otherwise only milk in his tea, There is no evidence of contact.

4. Private S., 1st Lancashire Fusiliers.—This case was a probable relapse from 1905. He had been in Citta Vecchia with simple continued fever from July 14 to September 4, 1905. He was readmitted January 4, 1906, with Mediterranean Fever, from Pembroke Camp. He was not personally examined, but a man of his company told one of us that he drank egg flips and rum and milk frequently. This man was a companion of his, and said he had often warned him of the danger of drinking milk, "as the doctor had warned them against milk drinking."

5. Gunner G., 96th Company, Royal Garrison Artillery.—Admitted January 5, 1906, from the officers' mess, where he had been an officer's servant for three months. He slept in a room by himself (No. 7, Servants' Quarters, Castile Mess). There is no history of contact. He had access to milk in the mess.

6. Lance-Corporal T., 1st Lancashire Fusiliers, a relapse from October 30, 1905, to January 15, 1906. He was readmitted February 17, 1906. This man stated that before his first illness he used to drink unboiled goats' milk, but had not done so recently.

7. Gunner L., 102nd Company, Royal Garrison Artillery, was admitted February 20, 1906, from Tigne Old Fort. Was a company cook for three months before he got ill. Goats' milk was used in the cook-house by the cooks, who used to buy it for their own use. This man stated that he had drunk goats' milk and soda water within 30 days of his getting ill.

8. Private W., 1st Lancashire Fusiliers, had been in Valletta Hospital exactly one month before his Mediterranean Fever admission on March 2, 1906, with rhinitis. He said he only drank milk in his tea, but he put the milk into the tea himself, *i.e.*, it was not served with the milk in it.

9. Private T., 1st Lancashire Fusiliers, was employed in the cook-house at Lower St. Elmo for 12 days before he fell ill. He used to drink unboiled goats' milk daily while there. He attributes his illness to this.

10. Private F., 1st Lancashire Fusiliers, was a relapse from 1905. That attack was probably contracted in hospital, as, within a month of his readmission for Mediterranean Fever, he had been in hospital with gonorrhœa, and said that he never felt well after his discharge from hospital after the cure of the gonorrhœa. He had milk in hospital and in his tea.

11. Sergeant M., 2nd Essex Regiment.—Admitted March 21, 1906, at Imtarfa. This case is a possible relapse from August 2, 1905, when he was in with simple continued fever until August 18, 1905, and then had a fortnight's light duty, and since then has suffered from pains in different limbs. He drank goats' milk on several occasions, but cannot give approximate dates. He had had goats' milk in tea in sergeants' mess.

12. Schoolmaster M. was admitted on March 23, 1906, but probably contracted his disease in January last. His wife also had the disease, and probably contracted it at the same time as her husband. They both drank unboiled goats' milk from the herd which supplied the Royal West Kent Regiment. Their son had Mediterranean Fever a year ago, when they were living at Sliema. Mrs. M. then nursed her son, and did not contract the disease. At present they are living in No. 2, Warrant Officers' Quarters, Strada Cappucini, and the son has never lived in the quarters. Several other cases of Mediterranean Fever occurred in this house, and a factor common to all these families was the milk supply.

13. Colour-sergeant S., 4th Worcester Regiment, was admitted into hospital on April 14 from No. 18, Verdala New Married Quarters. This man's child was admitted with Mediterranean Fever on March 2. He had been in camp for some time before his child got ill, but had slept in his house at least twice, February 3 and February 10. He was in Valletta Hospital March 19 to March 28, 1906, for sprain (knee). He and his wife both stated that condensed milk only was used in the house. We have reason to distrust this statement, as we were informed by a responsible officer of the regiment, who knew the family well, that they were well known in the regiment as goats' milk drinkers.

14. Private P., 2nd Essex, was admitted from No. 33 hut, Tigne (military police hut, a hut that has constantly changing inhabitants from different corps in the island), on May 7, after feeling ill for three days. Two other cases occurred of men who had been residents in this hut during the year: 1st, Private G., of the 4th Rifle Brigade, who was admitted on May 21 after leaving this hut only three days. The second case was a man of the West Kent Regiment, Private H. (see Case No. 31, West Kent Regiment), who was admitted into hospital on June 6. This man, however, had left the hut at Tigne over seven weeks when he got ill. None of these men's beds were near each other, and none of the three men were acquainted with each other. Private G., of the 4th Rifle Brigade, we believe, contracted his disease by drinking milk at his sister's house. This man's (G.'s) sister was married to a sergeant of the 1st Rifle Brigade, and he used to visit there

almost daily. The bloods of all the occupants of this hut were examined, with negative results. Private P., we considered, might have possibly contracted Mediterranean Fever by eating Gozo cheese, but we could form no opinion as to where the West Kent case contracted his disease. We did not consider the supervision at Tigne was all that could be desired, *e.g.*, we found that when condensed milk was alone supposed to be in use among the men at Tigne, goats' milk was still in use by the cooks in Tigne cookhouse. We, on one occasion, found goats' milk in the cookhouse. It was unboiled. We cannot exclude contact in the three cases from this hut, but at the time we did not think that contact was at all a sound explanation of them.

15. Private F., 1st Rifle Brigade, had no previous illness in Malta, was admitted on May 18, 1906, after feeling ill for five days. He lived in the Servants' Quarters, officers' mess, St. Andrew's Barracks, where he had a room to himself. He used to drink the milk which was left over from his master's morning tea daily. There is no history of contact. This milk supply was known later to come from a herd which contained infected goats.

16. Private G., 4th Rifle Brigade, was admitted on May 21, 1906, from St. George's Barracks, to which he had only returned from Hut No. 33, Tigne, a few days before. This was the most severe case of all the attacks during 1906 which ended in recovery. The probability of contact has already been discussed in this case (see Case 14). We think P. contracted his disease from milk at his sister's house in St. Andrew's Barracks.

17. Gunner L., 102nd Company Royal Garrison Artillery, was admitted from Room 4, A Block, Tigne, on May 14, 1906. The case is discussed along with Case 18.

18. Gunner H., 102nd Royal Garrison Artillery, was admitted May 25, 1906, from the same room as Gunner L. These men were intimate friends. They were in the habit of knocking about together, and both frequented the "Welcome to All" house at Sliema, where they often had tea together. They only had condensed milk in barracks. Gunner L., though admitted first, probably was ill before Gunner H. All the bloods of the other occupants of Room 4, A Block, were examined, and with negative results. We think that these men contracted their disease at the same time and place, which probably was not Room 4, and, though contact is a possible explanation, yet we do not think that milk infection can be excluded.

19. Gunner L., 99th Company Royal Garrison Artillery, was admitted from Tigne, Hut No. 32, on June 22. This man has complained of severe headaches on and off since April, when he had some teeth extracted. He was employed in Tigne cookhouse, and states he used unboiled goats' milk in his tea. It was in this cook-house we found the cooks using goats' milk, when the only barrack supply was supposed to be condensed milk. This man had been a cook for 13 months. There is no evidence of contact.

20. Sergeant-Major A., King's Own Malta Militia, was admitted on June 30 from 14th Strada Cappucini Warrant Officers' Quarters (see Schoolmaster M.'s case, No. 12, Series 4). His wife was admitted with the same disease May 12, 1906. There were two children in the quarters. The husband and wife used unboiled goats' milk, the children used condensed milk. Neither of the children got ill. It is improbable that the husband contracted the disease from his wife, as she was in hospital since May 12. During Mrs. A.'s stay in hospital she had a confinement, and a few days later *Micrococcus melitensis* was recovered from her milk. Beginning as a mild, she became a very severe attack. Shortly after her husband's admission his blood reacted 1/500,000. The baby which was born began to run a temperature at once, and its curve was exactly parallel with the mother's curve. The baby was bottle-fed, and infection was probably intra-uterine. We consider both Sergeant-Major A. and Mrs. A. to be cases of milk infection.

21. Sergeant K., 2nd Essex, was admitted June 2, 1906, after feeling ill for three days. He came from the Married Quarters, Imtarfa, 1.O Block. The family consists of Mrs. K. and four children. All the family are goats' milk drinkers. Mrs. K. had fever in June last. Sergeant K. had Malta Fever July 8 to July 16, 1904. His present attack is a relapse or a re-infection. This man states that he drank unboiled goats' milk, but not since April 22, 1906. The children in this family are said to have only boiled goats' milk. We consider that this was a milk infection.

22. Bombardier A., 65th Company Royal Garrison Artillery, was admitted from No. 41 Room, Upper St. Elmo, on July 8, 1906, after feeling ill since the end of May. This man, who was a pupil-teacher in the children's school, very frequently drank unboiled goats' milk in different shops in Valletta. There is no evidence of contact. He drank milk up to the time he got ill.

23. Private G., 2nd Essex, was admitted on September 8 from Marsumacetto Barracks, where he was attached to the Garrison Military Police. This man was cook to the police and used to buy a pint of goats' milk daily from any passing goat-herd. He used to drink it unboiled. The milk supply of these barracks is condensed milk.

24. Quartermaster-Sergeant C., Army Ordnance Corps, was admitted on September 7 from No. 7 Strada Birchircara, Sliema. He was a relapse from 1905. Mrs. C. also had Mediterranean Fever this year, and may have been infected through her husband, who this year was found to be excreting *Micrococcus melitensis* in his urine. When Quartermaster-Sergeant C. was ill last year, his son also had the disease at the same time and was nursed by Mrs. C., who then did not contract the disease. All the members of this family drank goats' milk, sometimes boiled and sometimes unboiled. Mrs. C. was under the impression that it was cows' milk they got, but found out later that her milkman only kept goats. Whether Mrs. C. got the disease from her husband or not, there is ample evidence that both father, mother, and son were running daily risk of infection through milk.

25. Private F., 4th Worcesters, was admitted August 13, 1906, from Fort Chambray, Gozo. This man, until 14 days before his admission, was employed in Fort Chambray cook-house, where the milk used was said to be cows' milk. It was this man's duty to sterilise it, and he said he used to use it in his tea. There was no history of contact.

26. Gunner H., 63rd Company, Royal Garrison Artillery, was admitted from Ricasoli on September 8, after having felt ill since July 11, 1906. On June 17, after a cricket match, he drank a quantity of unboiled goat's milk.

27. Gunner W., 65th Company, Royal Garrison Artillery.—After having felt ill since July 7, 1906, was admitted into hospital on September 7. This man had drunk goats' milk freely at Pembroke Camp in June last, and said it was commonly done in camp. He also drank egg flips, which contained goats' milk. This man was in Room 39, Upper St. Elmo, for the past 12 months, and no other case has occurred in the room this year. There is no history of contact. We believe this man, though only admitted in September, contracted his disease at Pembroke Camp in June, where he was from June 1 to June 14, as he began to feel ill within three weeks of leaving camp.

Series 5. *Men who were Probably Infected through Animals other than Goats.*

Gunner L., 65th Company, Royal Garrison Artillery, was admitted to hospital on July 30, 1906, and his blood reacted on the same day. He had felt ill for two days before his admission with headache and general malaise. He is the second case admitted from St. James Cavalier during the year. The first was Gunner N. (see

Case 8, Hospital List), who came from another room. Gunner L. came from Room 5, and had been in this room for three years. His employment was that of groom to Captain S.'s ponies. The stables where he worked were in St. James's Ditch, the surroundings of which were not in a very sanitary condition. The man's diet throws no light on the cause of his disease. One of the ponies with which he worked, pony "Billy," gave a good reaction against *Micrococcus melitensis*. This fact was not discovered until September, when another groom, Gunner W., was admitted (September 3, 1906) from the same room as Gunner L. had come from. W.'s blood, like that of the first groom, gave a positive reaction on the day of his admission. Gunner L. and Gunner W. had worked in the same stable, and both "had to do" with pony "Billy" and pony "Benghiza," the bloods of which ponies reacted well to *Micrococcus melitensis*. The bloods of eight men from Room 5 were examined at the same time, and none of them gave a positive reaction. Neither Gunner L. nor Gunner W. had ever taken goats' milk, and it seems highly probable that these men were infected through handling infected ponies. As to the way the ponies may have been infected it seems not improbable that their food may have been infected by urine of goats which a short time before used to be kept in large numbers in St. James's Ditch. None of the other occupants of the rooms got the disease, and none of them were grooms. It is much more probable that the ponies were the source of contagion than anything in the barrack room.

Gunner H., 99th Company, Royal Garrison Artillery, was another case in which we could find no other likely source than through infection from a pony. He lived in 21, Strada Jacinta Sliema, was groom to Captain A.'s ponies, and worked with a pony whose blood reacted well (1 in 10, and 1 in 20). Gunner H. was a married man, and had lived in his present house for the past six months. The house was in good sanitary condition, and no case of illness had occurred in it. His wife was in good health, and her blood gave a negative reaction. Gunner H. first fell ill on August 14, 1906, and was admitted to hospital on August 21. His blood reacted on August 20. The case from the first was one of great severity. Goats' milk was never used in his house. There was no evidence of contact except with the pony. The blood of the pony was examined for *Micrococcus melitensis*, but the attempt to recover it was unsuccessful. This is not a frequent path of infection, as the risk is confined to a very limited class of persons.

The remaining 33 cases have not been detailed, as we were unable to come to any definite opinion as to their causation, and they throw no light on the question of contact or other path of infection.

6. *Occupation in Relation to Attack.*

The liability to attack of the men of the Royal Army Medical Corps has already been discussed and need not be further referred to. In barracks, cooks, officers' servants and mess waiters have suffered severely.

Sixteen men employed in barrack cook-houses contracted the disease during the year, 12 of them being cases that occurred prior to the milk change. In nearly every instance there is a history of taking goats' milk.

Twelve men who were employed as officers' servants contracted Mediterranean Fever during the year, and in every case they were employed during the time when goats' milk was being used in the

officers' mess; or in instances where it had been stopped, the men fell ill within 30 days of the time when the mess ceased to use goats' milk.

Six men who were employed as mess waiters contracted the disease during the year, and all at the time the messes were using goats' milk. After the milk change this class of case ceased.

There does not appear to be any special liability to attack on the part of men who had been employed on sanitary work, such as work connected with drains, urinals, moving urine tubs, latrine work, etc.

The three cases of grooms which have just been detailed, and the three laboratory attendants who contracted the disease—one in 1905 and two in 1906—are of interest as pointing to contact as the path of infection.

7. *Prevalence amongst Officers.*

During 1906, 10 officers contracted Mediterranean Fever. One was an officer of the Royal Garrison Artillery about whom we obtained no information, except that goats' milk was used at the mess where he lived, and that it was used unboiled. Four were officers of the Royal West Kent Regiment. Lieutenant F. was admitted to hospital on March 18 after feeling ill for a fortnight. Lieutenant L. W. was admitted on April 16 after feeling ill for two days. Lieutenant W. was admitted on May 8 after feeling ill for four days. Captain S. was admitted on June 3, but had been feeling ill since the end of April. None of these officers had any real contact with each other beyond living in the same building and having meals together. No two cases occurred from one room. All these officers stated that they had only used boiled milk so far as they knew. Orders had been given that all goats' milk was to be boiled, and the Mess President was quite confident that these orders had been strictly enforced. By means of the ortol test it was proved on several occasions that the milk had not been boiled. All the West Kent officers got ill before they had ceased using goats' milk in the mess. Condensed milk was taken into use on May 25. Captain S., though admitted in June, was ill from the end of April.

Two officers of the 1st Rifle Brigade got ill about the same time. Lieutenant Hon. W. was admitted on April 21 after feeling ill for about a week. Captain D. was admitted on April 25 after feeling ill for 10 days. We could find no connecting link between these two officers, except that one of them began to take porridge and milk three weeks before he got ill, while the other officer had begun taking porridge and milk a month before he got ill. One of the officers said he knew the milk was boiled, because on the first occasion he used it it was hot, but that he always got the milk cold

afterwards, as he had scolded his servant for bringing him hot milk. It appears probable, in consequence of this scolding, that the officers in future had unboiled milk. There was no evidence of contact in either of these cases.

Captain P., Hampshire Regiment, was admitted to hospital on June 10, after feeling ill for a week. He was living in private lodgings and used to have all his meals, except his breakfast, at the Union Club. This officer's servant got ill about three weeks before his master. He used to use unboiled goats' milk for his tea. His servant used to have tea at his master's quarters. We think that master and servant were most probably infected by milk.

Lieutenant B., 4th Worcester Regiment, was admitted into hospital on July 1 from the Officers' Quarters, Verdala Barracks. This officer was on the sick list for five days about Christmas, 1905, with simple continued fever, and again in Egypt he had another attack of fever which lasted for a few days. This was about May 20. Since then he has never felt fit and had headache frequently. This officer used to take porridge and goats' milk before he went to Egypt, not since he returned to Malta. It is extremely probable that the disease was contracted before he went to Egypt. There is no evidence of contact. No other officer of this regiment has had the disease this year.

Lieut.-Colonel Y., Army Pay Department, was placed on the sick list on October 11, 1906. We know nothing about this officer's illness, which took place after we left Malta.

The deductions to be drawn from the incidence of the disease among officers are :—1. In the cases of the officers about whom we obtained personal information, all except two, there was a history of drinking goats' milk. 2. Since goats' milk has been discontinued, no other officer has been attacked by Mediterranean Fever.

8. *Prevalence in Married Quarters.*

A family forms a small group of individuals living in close association, and in each set of married quarters there are many such small groups, each living amidst the same general surroundings, but differing from each other often in one important respect, namely, in regard to the kind of milk used.

This year's examination of the kind of milk used by the families showed the following results.

Four hundred and sixty-five families were examined. These families comprised 1830 persons, 465 men, 465 women, and 900 children. Among them there occurred, during the year, 59 cases of Mediterranean Fever, 3·2 per cent. The men gave 21 cases, and the women and children each gave 19 cases, the respective ratios being, men 4·5 per cent., women 4·1 per cent., children 2·1 per cent.; 266 families, composed of 266 men, 266 women, and 436 children, with a total of 968 persons, whose only supply was condensed milk, gave 10 cases of Mediterranean Fever, 1·03 per cent.; while

199 families, consisting of 199 men, 199 women, and 464 children, total = 862 persons, whose milk supply was either goats' milk alone or goats' milk and condensed milk, gave 46 cases of Mediterranean Fever, being a ratio of 5·3 per cent.

		Per cent.
Of the 21 men,	15 had goats' milk	71·5
,,	4 had condensed milk.........	19·0
,,	2 milk supply unknown	9·5

These four men include one (Sergeant S.) whose milk history is unknown and he is assumed to have used condensed milk only.

		Per cent.
Of the 19 women,	9 had unboiled goats' milk	47·4
,,	8 had boiled goats' milk	42·1
,,	2 had condensed milk only	10·5
Of the 19 children,	8 had boiled goats' milk	42·1
,,	5 had unboiled goats' milk	26·3
,,	4 had condensed milk	21·1
	The histories of two are unknown	10·5

It is seen that, for this year, families whose only supply was condensed milk give a Mediterranean Fever rate of 1·03 per cent., while families which used goats' milk, either entirely or in part, give a rate of 5·3 per cent., *i.e.*, there are more than five times as many cases in the group using the dangerous article than among those using the safe one. The figures obtained with regard to those who used boiled goats' milk as compared with those who used unboiled goats' milk do not show the same amount of protection as is shown by the condensed milk group compared with the goats' milk group. This is only what one might expect. In our inquiry some women said they boiled the milk always, others said the milk was sometimes boiled, not always, others again said it was "scalded," and again that it was only used unboiled for tea. The only safe comparison to make, or one which with any degree of probability represents the truth, is the comparison of families which used condensed milk against families which used goats' milk, boiled or unboiled, and, using this comparison, the figures are all in favour of the condensed milk users.

The following table gives the monthly distribution of the disease among the married men, women and children during the year.

1906.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Men	1	0	1	3	3	6	1	2	1	1	1	1	21
Women	0	1	0	3	7	1	2	1	2	0	1	1	19
Children	0	1	2	0	5	1	5	3	0	1	1	—	19

During the first six months of the year the men had 14 cases of Mediterranean Fever and during the second half of the year seven cases.

The women, during the first six months, gave 12 cases, during the second six months seven cases of Mediterranean Fever.

The children, during the first six months, gave nine cases, and during the second six months ten cases of Mediterranean Fever.

There are no data against which these figures can be compared, as no monthly distribution of the disease among families has been given in previous records.

9. *Mosquitoes and other Biting Insects.*

In none of the cases examined this year could we obtain any evidence of the spread of Mediterranean Fever through the agency of mosquitoes or other biting insects. The majority of the patients stated that they had not been bitten, and at the time we examined them they had no visible marks. Such evidence is, of course, very weak for determining a question of this nature. Evidence on which we place more importance is, that we examined a large number of men in barracks, and of children in quarters, who had been severely bitten by both mosquitoes and sand flies, some sufficiently badly bitten as to cause their admission to hospital through injury to the skin caused by scratching. None of these severely bitten individuals were subsequently admitted with Mediterranean Fever. It is hard to believe, supposing the mosquito to play any large part in the spread of this fever, that this should have been the case. The disease was also most prevalent in the first six months of 1906, when mosquitoes were few, and the prevalence was far less in July, August, and September, when they were abundant.

From May to the end of September we examined 222 mosquitoes sent to us from different barracks in Malta, with the following results: From Floriana Barracks 97 specimens were examined, of which 52

were *Culex pipiens* or *fatigans*, 29 were *Stegomyia fasciata*, and 16 were *Culex spathipalpis*. From St. George's Barracks—39 mosquitoes, of which 23 were *Culex pipiens*, 10 were *Acartomyia Zammitii*, and 6 were *Stegomyia fasciata*. From St. Andrew's Barracks we received 42 mosquitoes, of which 27 were *Culex pipiens*, 11 were *Stegomyia fasciata*, and 4 were *Acartomyia Zammitii*. From Tigne Barracks and married quarters 44 mosquitoes were received, of which 16 were *Culex pipiens*, 18 were *Stegomyia fasciata*, and 10 were *Acartomyia Zammitii*.

As the *Stegomyia fasciata* did not appear until June, and the *Acartomyia Zammitii* ceases in September, neither of these species can have much to say to the occurrence of cases during the cold weather months.

On the initiative of the Principal Medical Officer, Colonel MacNeece, a joint Committee, consisting of representatives of the Civil Government, and the naval and military authorities, was appointed to discuss the question of ways and means of lessening mosquito prevalence in Malta. The Committee had not reported up to the time we left the Command.

10. *Preventive Measures.*

The measures in use when we arrived in Malta were as follows :—

The sanitary conditions of barracks and quarters were under constant supervision, and there was much sanitary activity on the part of both medical and regimental authorities. Courses of lectures are regularly given by the Command sanitary officer, Major W. L. Gray, R.A.M.C., on subjects relating to barrack sanitation and the laws of health.

In barracks and married quarters, the sterilisation of goats' milk by boiling had been strictly enjoined, and the hospital supplies were dealt with by pasteurisation in the case of Valletta and Cottonera, and by boiling in the case of the other hospitals.

Special care was being paid to keeping latrines and urinals in a satisfactory sanitary state.

The kit, bedding, and clothing of every man reporting sick with fever was set aside in a store reserved in each barracks for the purpose, until it could be disinfected. Spraying, steeping, and steam disinfection were the methods in use.

A sample of blood was taken from each case of fever, and was sent to the laboratory for examination.

On a case being diagnosed Mediterranean Fever, the sanitary officer and others concerned were immediately notified.

If a second case of Mediterranean Fever was admitted from the same barrack room, the room was evacuated and it was disinfected by spraying, scraping, and limewashing.

In hospitals, special feeding cups, urinals, and bedpans were set aside and marked for the use of Mediterranean Fever patients.

Attendants on the sick had strict instructions to be careful as to personal disinfection, and there was a standing order that they were to wash their hands in a disinfectant and to use the nail brush immediately after handling bedpans, soiled bedding, and clothing, etc.

Questions relating to the application of additional preventive measures were discussed with the Principal Medical Officer from time to time as occasion arose, and twice in conference with H.E. the Governor. At the first of these conferences it was represented that, in order of importance, practical measures were: alteration of the milk supply; isolation of cases; disinfection; segregation and observation of contacts; care that the men get their full 750 cubic feet space; and attention to general sanitation.

The Milk Supply.—The discontinuance of the use of goats' milk in barracks and hospitals was pushed at the end of April. It became an accomplished fact in hospitals by May 17, and in barracks between that date and June 7. The details have already been fully discussed (p. 166).

Isolation of Cases.—Shortly before our arrival in Malta the question of isolating cases of Mediterranean Fever in one hospital was raised by the Principal Medical Officer, and it had been decided to let it stand over until the Members of the Commission arrived. After discussion, it was decided to use Valletta Hospital, as it was centrally situated, and also because it was the most convenient from an administrative point of view. Accordingly, the hospital began to be used for this special purpose from May 1, 1906. We recommend the continuance of the practice of isolating cases of Mediterranean Fever.

As Valletta Hospital is situated in a densely populated neighbourhood, where mosquitoes are generally plentiful, it was resolved to make the windows and doors of the wards mosquito-proof, so as to prevent the entrance of mosquitoes and the possible carriage of infection by them. The windows and doors of the rooms used as barrack rooms by the detachment of the Royal Army Medical Corps were also mosquito netted. We now think that, as infection is probably seldom, if ever, conveyed by mosquitoes, this measure was perhaps one that might have been dispensed with, although it certainly was useful in excluding mosquitoes and also flies. It was considered by the staff and by the nursing sisters that the mosquito netting, even although the windows were constantly open, interfered with the free passage of air and rendered the wards uncomfortably close. The same view was strongly held by the men with regard to the barrack room netting. On the whole, the balance of evidence is against renewing it.

Segregation and Observation of Contacts.—The procedure recommended and which was adopted was as follows:—

(1) To enable the disinfection of barrack rooms to be thoroughly carried out. The room was evacuated, and separate accommodation was found for the men until the disinfection of the room had been completed, after which they were allowed to return to it.

(2) For the detection of ambulatory cases. The "contacts" were kept under observation and examinations for agglutination reactions were carried out.

(3) Men who had been discharged from hospital after treatment for fever were kept under observation.

Examination of Blood of "Contacts" and others.—Five hundred and seventy-four samples of blood were examined during the year.

Thirty samples were taken from men of the 2nd Battalion Essex Regiment, who had had Mediterranean Fever in 1904 and 1905. Twenty-eight gave a positive reaction against *Micrococcus melitensis.*

Six ponies were examined as contacts, of which the blood of three gave a positive reaction.

Bloods from 140 Maltese, employed in barracks, were examined, of which 11 gave a positive reaction. These include one man whose serum reacted against both *Micrococcus melitensis* and a *paratyphoid bacillus*, and another man whose serum reacted against a *paratyphoid bacillus* only. The last case was diagnosed simple continued fever. Excluding this case, positive reactions were obtained in 7·7 per cent. of the Maltese examined.

Three hundred and seventy samples of blood from men of British troops were examined, 37 of which gave a positive reaction against *Micrococcus melitensis*—that is, 9·2 per cent.

The blood of one British soldier gave a positive reaction against a *paratyphoid bacillus.*

The urine of 26 cases was examined for the presence of *Micrococcus melitensis.* It was recovered once from the urine of a married man, whose wife contracted the disease during the summer of 1906. Her husband was a relapse from the previous year. The wife, no doubt, may have been infected from this source; but both husband and wife drank goats' milk freely, so that possibility of milk infection cannot be excluded.

The blood of "contacts" of 18 families was examined. In three a positive reaction was obtained; all three were persons who never manifested any symptoms of Mediterranean Fever.

Positive reaction without symptoms was also observed in the case of four men of the Royal Engineers. Seventy-four samples of blood were examined from men of this corps, and four gave a positive reaction against *Micrococcus melitensis.* These four men had never been ill, and have not since manifested any symptoms of the disease.

The dilutions used in the blood examinations were 1 in 10 and 1 in 20. The examinations were made in the laboratory of the Mediterranean Fever Commission.

From these examinations it appears that the blood of individuals who have no history of previous attack, and who do not for long periods after manifest any apparent symptoms, may give a positive reaction. We understand by this phenomenon that certain persons may be invaded by *Micrococcus melitensis* without showing any signs of illness.

Although we were on the look out for cases in which the disease might have been contracted from ambulatory cases, and we also thought that special liability might be shown by men employed in keeping latrines and urinals clean, or in handling urine tubs, we failed to observe any such cases. The three laboratory cases, the three men who were admitted for Mediterranean Fever, and who were found to have been constantly grooming ponies the blood of which gave good positive reactions, the probability that goats themselves may be infected through breaches of the surface, make it evident that contact cannot altogether be disregarded. In view of the fact, however, that close association with cases of the disease in the Home hospitals, both as regards sick attendants and patients under treatment in the same wards for other ailments, has never been known to result in the spread of Mediterranean Fever, contact is probably an infrequent factor.

Disinfection.—Up to the middle of April, 1906, the practice was to carry out disinfection of kit and bedding in every case of Mediterranean Fever, but the room was not disinfected unless a second case occurred in it. This was altered to disinfection of the room on the occurrence of the first case. If subsequent cases occurred, the bedding and clothing of the case was dealt with, but the room was not again disinfected unless required by special circumstances, and such, as a matter of fact, never occurred. The disinfection arrangements were carried into effect under the supervision of the sanitary officer, Major Gray.

Attention to General Sanitation.—A good deal of care was bestowed on the condition of latrines, urinals, urine tubs, and urine tub stands on account of the possibility of such places being fouled by infected urine, but, as we have just pointed out, we have no evidence of the spread of Mediterranean Fever in this way. It was suggested that latrine seats should be scrubbed daily with a 2½-per-cent. carbolic solution, and that all other woodwork should be scrubbed once a week. In the case of dry earth closets, placing carbolic solution in the pails was recommended, and, to prevent spillage, that a spadeful or two of dry earth might be added to the contents before the pail was moved. Urine tubs and urine tub stands were to be kept scrupulously clean, and it was suggested that arrangements should be made for providing means for washing the hands of men employed on urine tub fatigues. Swarms of flies round ashbins were often noticed. This was caused by the

contents getting strewn over the ground, through the doors being left open, and the covers left up. Flies were often observed to be abundant in kitchens, and especially in the places where cooking is carried on in the regimental coffee shops. This was usually due to grease stains about the tables or on the floors. Regular scrubbing keeps down their number largely. Flies were often present in large numbers in latrines, and we found an excellent plan in use in the St. Andrew's Barracks, namely, the application of a thin layer of kerosene oil once or twice a week to all woodwork about the latrine, except the seats. It does not take much, and these latrines were remarkably free from flies.

Special Sanitary Staff.—At the time we left Malta, all the infantry units had adopted the plan of having the sanitary work in barracks done by a permanent staff of men, consisting of two men per company under the orders of the quartermaster, in place of the old practice of having one or two permanent men and having the greater part of the sanitary work done by fatigue parties. One or two of the quartermasters informed us that they had found the change of the greatest help to them, and that they could get sanitary work more systematically and, therefore, more efficiently done.

11. *Results of the Work of* 1906.

The conclusions drawn from a critical examination of the military and naval observations are given in detail in the general summary (p. 244). It may be stated here, however, that the investigations relating to the garrison indicate:—

1. That the goat is the primary source from which the disease is spread to man.

2. That goats' milk is the common vehicle for the *Micrococcus melitensis*.

3. That flies may act as carriers.

4. That the other paths of infection play but a minor part. Contact and dust are possible, but probably very infrequent, factors, while the case for mosquitoes or other biting insects is not proven.

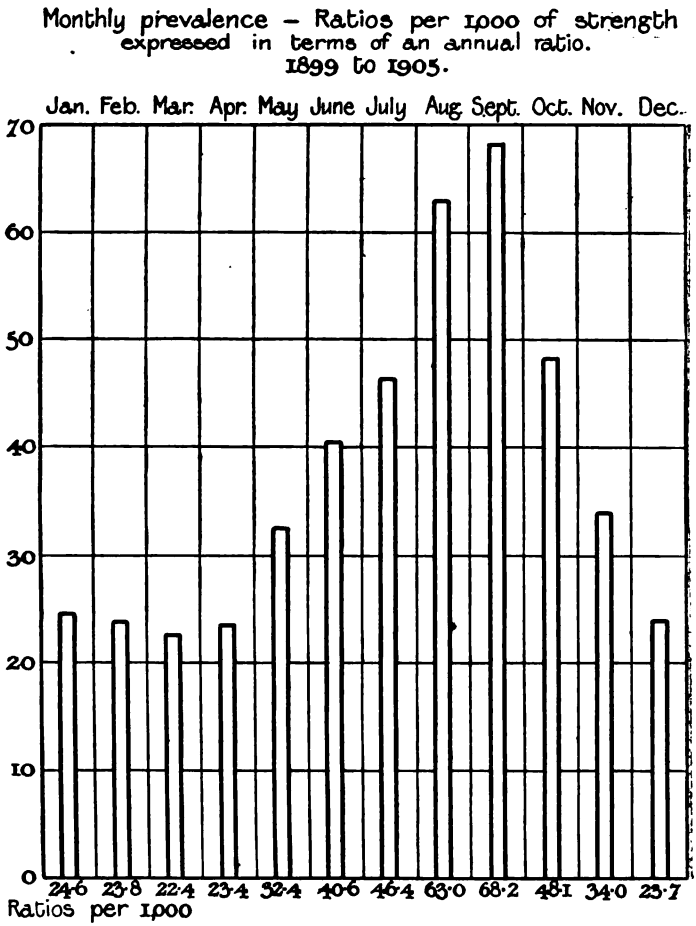
The use of goats' milk is the one factor which has come into special prominence in the investigations of the probable causation of cases of the disease in 1906. A history of goats' milk was traced in 70·6 per cent. of the cases investigated up to the time we left Malta at the end of September. Those who are most in the way of using milk appear to be most liable to attack—for instance, officers are more liable to attack than men; and, probably for a similar reason, a special liability appears to attach to certain occupations, such as cooks, officers' servants, and mess waiters.

The cutting off of the use of goats' milk from barracks and hospitals has constituted an experiment on a very large scale, and one that has been, so far, attended by exceedingly satisfactory results, as will be observed from a study of the following tables and Charts 5 and 6:—

Table XV.

Year.	Mediterranean Fever. Admissions.	Simple continued fever. Admissions.	Enteric fever. Admissions.	Total admissions for continued fevers.	Mediterranean Fever. Ratios per 1000. Admissions.	Mediterranean Fever. Ratios per 1000. Deaths.	Simple continued fever. Ratios per 1000 admissions.	Enteric fever. Ratios per 1000 admissions.	Total continued fevers. Ratios per 1000 admissions.
1897	279	1275	34	1588	34·7	1·49	158·9	4·2	197·9
1898	200	1509	62	1771	27·1	1·08	204·2	8·4	239·6
1899	275	1107	41	1423	37·0	1·21	149·1	5·5	191·6
1900	158	1158	31	1347	19·4	0·98	142·2	3·8	165·5
1901	253	1205	41	1499	31·1	1·10	148·1	5·0	184·2
1902	155	981	38	1174	17·7	0·68	112·0	4·3	134·0
1903	404	781	18	1203	45·4	1·01	87·7	2·0	135·1
1904	320	1350	79	1749	35·1	1·82	148·0	8·7	191·8
1905	643	1199	64	1906	77·5	1·93	144·6	7·7	229·8
1906	163*	504	9	676	24·5†	0·15	75·6	1·4	101·5

* Includes 19 readmissions.
† Excluding readmissions, the ratio is 21·6.



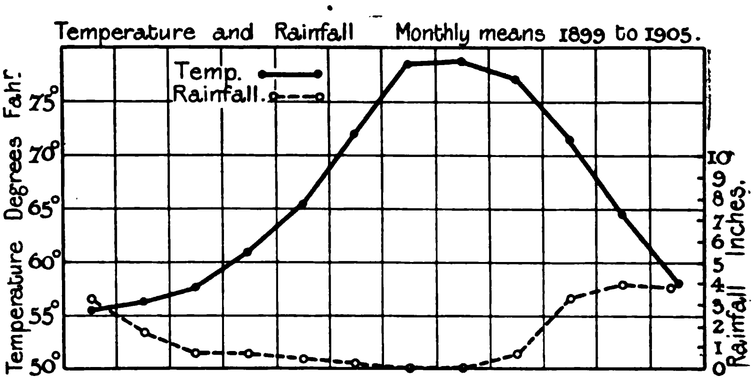


Chart 5.—Mediterranean Fever amongst the troops in Malta.

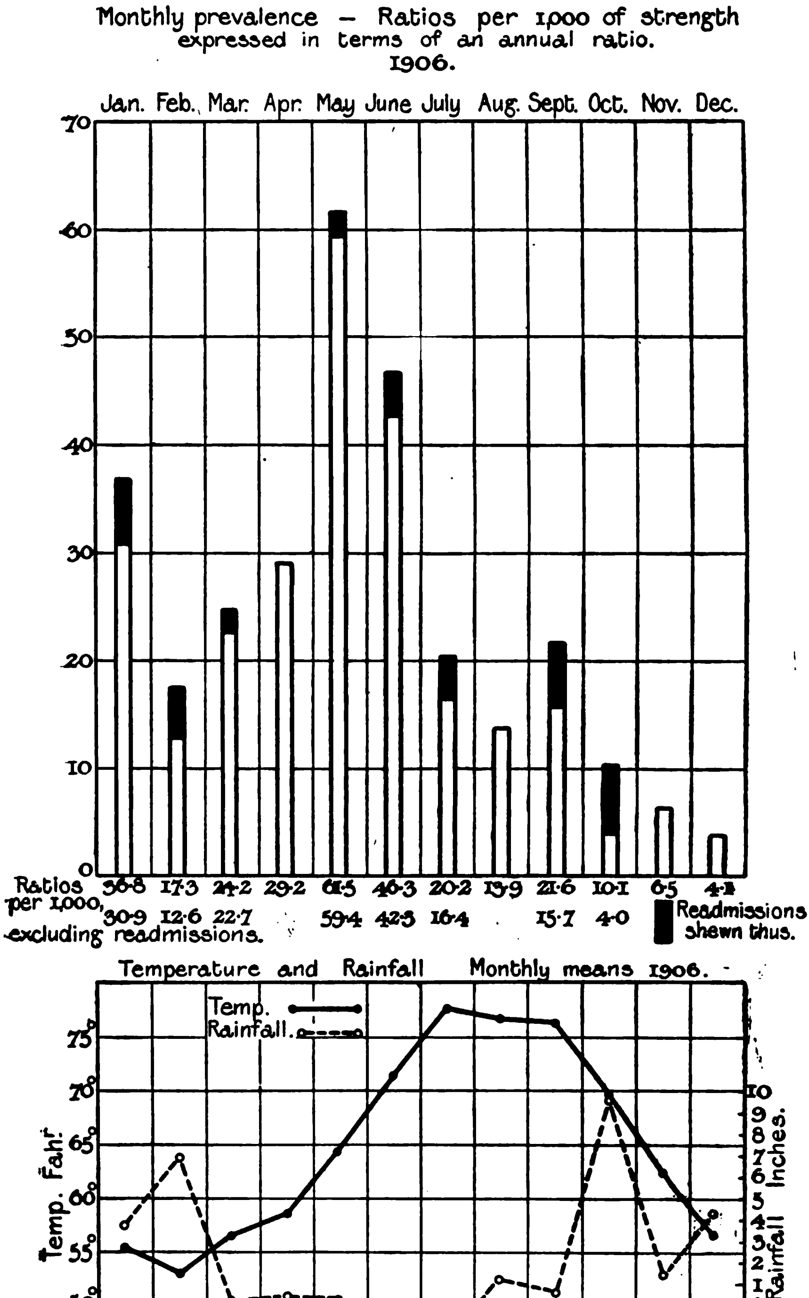


Chart 5.—Mediterranean Fever amongst the troops in Malta.

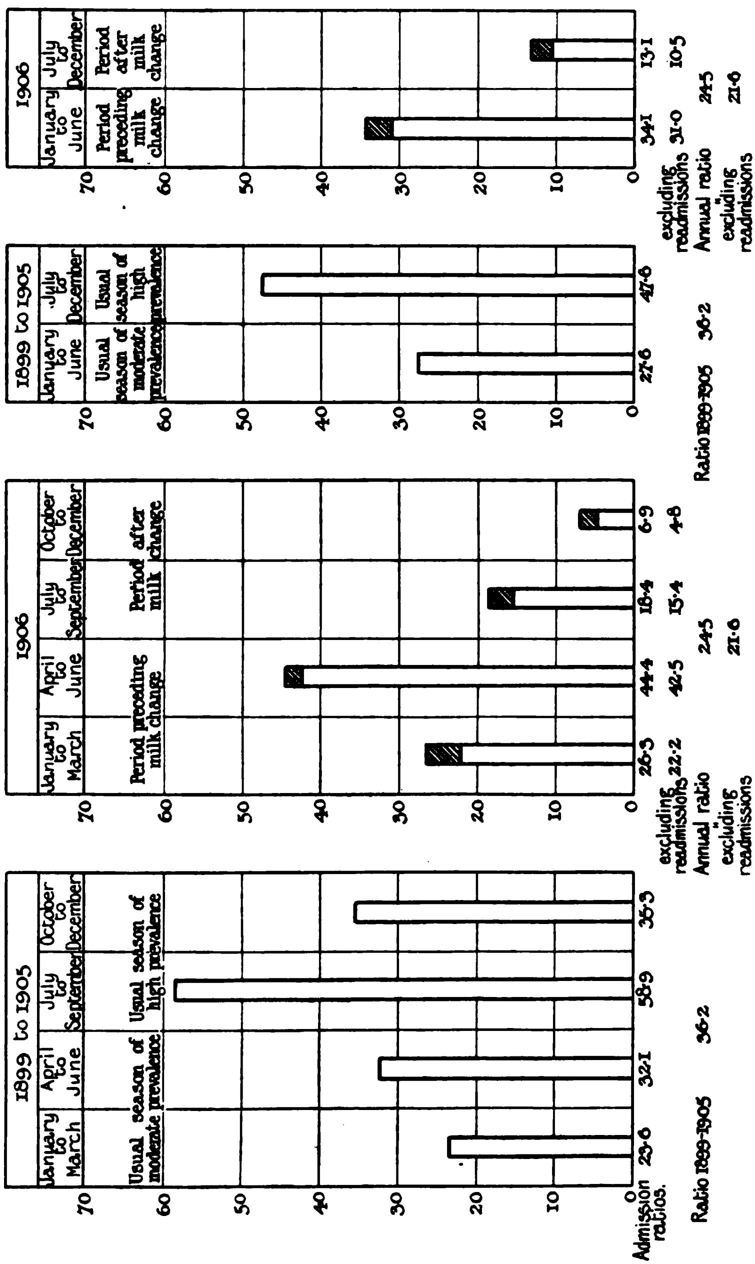


Chart 6.—Prevalence of Mediterranean Fever in 1906 as compared with 1899—1905, to show the reduction of prevalence during the last six months of 1906.

Table XVI shows the monthly prevalence of Mediterranean Fever in the Malta garrison during 1906. Tables XVII and XVIII give similar information regarding simple continued and enteric fevers. The average number of cases and the average ratios for the seven years' period 1899 to 1905 are added in each instance for comparison.

Table XVI.—Mediterranean Fever.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Admissions 1906 ...	25	11	16	18	30	23	11	8	11	5	3	2
Monthly average 1899—1905	18	15	16	16	23	28	34	45	46	34	23	17
Ratios—												
1906	36 ·8	17 ·3	24 ·2	29 ·2	61 ·5	46 ·3	20 ·2	13 ·9	21 ·6	10 ·1	6 ·5	4 ·1
1899—1905	24 ·6	23 ·8	22 ·4	23 ·4	32 ·4	40 ·6	46 ·4	63 ·0	68 ·2	48 ·1	34 ·0	23 ·7

Table XVII.—Simple Continued Fever.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Admissions 1906	5	3	4	7	9	117	185	66	61	29	15	3
Monthly average 1899—1905	15	11	19	23	32	164	308	212	181	69	23	13
Ratios—												
1906	7 ·4	3 ·2	3 ·0	6 ·5	18 ·5	215 ·4	331 ·4	114 ·6	120 ·0	58 ·6	32 ·4	6 ·1
1899—1905 ...	21 ·0	16 ·4	26 ·4	33 ·2	45 ·7	238 ·1	426 ·1	297 ·4	266 ·7	97 ·0	33 ·2	19 ·2

Table XVIII.—Enteric Fever.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Admissions 1906 ...	1	—	—	4	3	—	—	1	—	—	—	—
Monthly average 1899—1905	3	2	3	1	1	3	7	6	3	5	5	5
Ratios—												
1906	1 ·5	—	—	6 ·5	6 ·2	—	—	1 ·8	—	—	—	—
1899—1905	3 ·60	3 ·28	4 ·81	1 ·44	1 ·81	3 ·73	10 ·08	8 ·61	4 ·85	7 ·85	6 ·60	6 ·95

The satisfactory character of the decreased prevalence observed during the second half of 1906 is even better shown by tabulating the figures relating to Mediterranean Fever incidence by quarters (see also Chart 6).

Table XIX.—Mediterranean Fever.

Comparison of 1906 with the Period 1899—1905, by Quarters of the Year.

	January to March.	April to June.	July to September.	October to December.
Admissions, 1906* ...	52	71	30	10
Average for period 1899—1905	49	67	125	74
Ratios, 1906	26·3	44·4	18·4	6·9
Average for period 1899—1905	23·6	32·1	58·9	35·3
* 1906, excluding re-admissions—Ratios	22·2	42·5	15·4	4·8

While it is shown even better still by dividing the year into two six months' periods, and the more so because the first six months represents the period preceding the milk change, and the second six months the period after the milk change.

Table XX.—Mediterranean Fever.

Comparison of 1906 with the Period 1899—1905, by Half Years.

	Admissions.		Ratios per 1000.	
	January to June.	July to December.	January to June.	July to December.
1906*	123	40	34·1	13·1
Average for period 1899—1905	116	199	27·6	47·6
* 1906, excluding re-admissions	112	32	31·0	10·5

In the two units which showed most prevalence in 1906 the disease was practically confined to the first half of the year.

1st Battalion Royal West Kent Regiment.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
7	3	6	6	8	10	—	2	2	—	—	—

See also remarks at the end of the discussion of the cases which occurred in this regiment (p. 192).

Royal Army Medical Corps.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
3	3	1	3	5	1	—	—	2	—	—	—

See also remarks (p. 200).

The prevalence amongst officers was also chiefly confined to the first six months of 1906.

Officers.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
—	1	1	2	2	2	1	—	—	1	—	—

The prevalence amongst soldiers' wives is not so strictly confined to the first half of the year, and the figures for the children are nearly equally distributed between the two halves of the year. It is difficult to control the introduction of goats' milk into married quarters. The last two cases amongst the women, reported in November and December respectively, used goats' milk. The Principal Medical Officer, Malta, makes the following comment regarding one of these cases:—"I find that in spite of personal warnings and the prevention of goats entering barracks, married people persist in obtaining goats' milk outside." Commanding officers are communicated with when such cases come under observation.

Soldiers' Wives.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
—	1	—	3	7	1	2	1	2	—	1	1

Children.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
—	1	2	—	5	1	5	3	—	1	1	—

It may be reasonably claimed that since the use of goats' milk was discontinued in barracks and hospitals there has been a great reduction in the prevalence of Mediterranean Fever. This is well shown in Tables XIX and XX and Chart 6. By a glance at Chart 6 it will be observed that Mediterranean Fever showed more than average prevalence during the six months of 1906, in comparison with the corresponding months of the seven years' period 1899—1905. This seemed to presage that in the second half of the year, the period when the disease is generally at its worst, more than ordinary prevalence was to be expected, instead of which the very reverse has happened. Concurrently there has also been a reduction in the admissions for simple continued fevers, which was also most marked in the second half of the year. We may have here foreshadowed the decline of Mediterranean and simple continued fevers in Malta, just as we have already seen in the first part of this report that their disappearance from Gibraltar was also simultaneous in character.

It is, of course, impossible to build upon six months' results as on a sure foundation. If, however, the milk change is the true explanation of the reduction, it will stand the test of time, and by that alone can the importance of goats' milk as the chief causative factor be established. But it must, at the same time, be remembered, that unless the dangers of infected goats' milk are being constantly kept in view, and constantly brought to the notice of soldiers and soldiers' families, there is always the possibility of lapse to old ways, with its attendant risks of spread of the disease.

DIVISION III.—CIVIL.

We do not propose to enter upon a detailed discussion of the prevalence of Mediterranean Fever amongst the civil population. Accurate information is difficult to obtain, and the subject of civil prevalence has already been dealt with by Dr. Johnstone in the 1904 Reports, together with topographical details and a general sanitary survey of the Maltese islands. We accordingly limit ourselves to bringing distribution tables up to date, and to a brief discussion of some of the more important points connected with the disease as observed amongst the civil population.

1. *Prevalence of the Fever among the Civil Population.*

The following table shows the monthly distribution of cases in 1906, compared with the average monthly prevalence during the 10 years 1896 to 1905 :—

Table I.—Civil Population. Monthly Distribution of Cases in 1906.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Average— 1896—1905	32	26	30	30	48	58	87	87	69	64	52	49	632
1906	20	27	28	54	81	109	108	103	71	32	37	28	698

This table shows that cases of Mediterranean Fever are notified all through the year, and that there is an increase in the notifications during the hot weather months.

The notifications for 1906 showed increased prevalence up to the end of September, after which they are below the average during the three last months of the year. The improvement indicated by the figures for the last quarter may possibly be the result of the attention of the public having been largely drawn to the dangers of goats' milk. This has been helped by articles in the local press, and also through a pamphlet issued by the Public Health Department. Public interest in the matter was also roused by the strike of the goat-herds in the last fortnight of May, and we are informed that, during the closing months of the year, the attention of the public has also been called to the subject by the clergy.

2. *Age and Sex in Relation to Attack.*

The relation of age and sex to the occurrence of Mediterranean Fever is shown in the following table:—

Table II.

Years.	July 1, 1904—June 30, 1905.			July 1, 1905—June 30, 1906.		
	Males.	Females.	Total.	Males.	Females.	Total.
1— 5	6	11	17	13	6	19
6—10	18	23	41	25	24	49
11—15	23	48	71	34	35	69
16—20	54	51	105	62	49	111
21—25	56	50	106	71	46	117
26—30	49	40	89	45	53	98
31—35	31	28	59	31	29	60
36—40	26	20	46	29	30	59
41—45	21	16	37	20	30	50
46—50	16	21	37	19	18	37
51—55	14	15	29	18	16	34
56—60	7	16	23	20	15	35
61—65	8	5	13	12	7	19
66—70	9	4	13	4	2	6
71—75	—	—	—	5	2	7
76—80	1	—	1	1	1	2
81—85	—	—	—	1	1	2
86—90	1	—	1	—	—	—
Total ...	340	348	688	410	364	774

It will be observed from Table II that the disease may occur at any age, but that it was most common amongst persons between 10 and 30 years of age. A case was observed in the garrison during the year in which a baby was born at the time the mother was in hospital for the disease, and the infant had a temperature the curve of which corresponded almost exactly to that of the mother. Of 1462 notifications during the two years, 750 were males and 712 were females. The sexes would, therefore, appear to be about equally liable.

Case Mortality.—The case mortality for the 10 years 1896 to 1905 works out 9·5 per cent. as compared with 3·3 per cent. for the garrison. The returns of mortality to attack have shown progressively increasing figures during the last three years, as under:—

	Percentage of deaths to cases notified.
1902—03 (April 1—March 31)...	8·1
1903—04	10·3
1904—05	13·2
1905—06	14·2

This increase is attributed by the Chief Government Medical Officer partly to cases of enteric fever having been reported as Mediterranean Fever, and partly to the return of cases as Mediterranean Fever which would have been formerly otherwise classified. He bases these assumptions on the fact of the general death rate showing decrease, and considers, therefore, that the increase observed in the death rates from fevers is chiefly a transfer of figures from other heads. The high case mortality indicates that a great many cases of Mediterranean Fever occur which are not notified. It is possible that many cases do not come under observation at all, and we have met with other instances in which notification has been delayed till the patient was at death's door. It must be remembered, too, that blood examinations are the exception and not the rule.

Irregular Prevalence of the Disease in Towns and Villages.—As pointed out in the military part of the report, there is great variation from year to year in the incidence of the disease in different barracks, so it will be observed from consideration of the figures in Dr. Johnstone's report, Part II, Commission Reports, p. 18, that similar variation of prevalence is also observed in the case of the civil communities. For example, the Floriana district shows more than the average number of notifications in 1896, 1899, 1904, and 1905, while the number was low in 1895 and 1898, and moderate in 1901 and 1902. Birchircara appears to have had an unusual prevalence of cases in 1899 as compared with other years. Notabile and Rabato had large prevalence in 1899, and we have already seen that there was a sharp outbreak of the disease in that year in the neighbouring Imtarfa Barracks. Zebbug had large prevalence in 1896, 1900, 1902, and 1905, but the notifications were much fewer in 1897 to 1899, 1901, and 1904. The differences are so very marked as to point to a factor which is liable to irregular variation, rather than to the presence of a condition or conditions of a more permanent kind, and it is thought that an infected milk hypothesis seems best to explain these variations.

Distribution of Mediterranean Fever in Malta.—Table III shows the distribution of the disease in the towns and villages during the two years from July 1, 1904, to June 30, 1906. For purposes of comparison, the first column gives the ratios per 10,000 of the population for the 10 years' period 1894 to 1903, which are taken from Dr. Johnstone's report.

This table shows :—

1. The very general character of the distribution of the disease amongst the towns and villages of Malta.

2. That while the prevalence in the rural areas remains fairly steady, there has been an increase in the notifications in the urban and suburban areas. It is impossible to say whether this increase is due to greater prevalence of Mediterranean Fever or to the greater

Malta.	Average number of cases of Mediterranean Fever per year per 10,000 of population 1894—1903. *	From July 1, 1904, to June 30, 1905.			From July 1, 1905, to June 30, 1906.			Number of goats in each place at end of June, 1906.	Relation to population.
		Estimated population.	Cases of Mediterranean Fever.	Ratio per 10,000.	Estimated population.	Cases of Mediterranean Fever.	Ratio per 10,000.		
Urban drained area.									
Valletta	14·3	24,249	54	22·2	24,508	62	25·3	—	—
Floriana	45·7	6,140	37	60·2	6,241	70	112·1	—	—
Cospicua	16·6	13,130	18	13·7	13,271	16	12·0	47	—
Vittoriosa	22·9	8,008	25	31·2	8,106	42	51·8	274	—
Senglea	10·5	8,950	12	13·4	9,116	16	17·5	8	—
	18·8	60,477	146	24·1	61,242	206	33·6		
Suburban area, partially drained.									
Sliema and St. Julian	43·3	13,066	100	76·5	13,182	103	77·3	898	1—15
Hamrun	64·8	11,691	47	40·2	11,956	50	41·8	2,635	1— 4
Misida and Pieta	57·1	4,211	36	85·4	4,282	31	72·3	2,239	1— 2
Birchircara	54·2	9,101	66	72·5	9,219	56	60·7	1,454	1— 6
Curmi	6·0	9,145	11	12·0	9,307	20	21·4	553	1—17
Zabbar	38·6	6,260	18	28·7	6,358	12	18·8	1,024	1— 6
Tarxien and Paula	22·6	5,488	18	32·8	5,573	36	64·6	189	1— 5
	41·8	58,962	296	50·2	59,877	308	51·4		

Rural area.									
Notabile and Rabato	30·2	8,226	42	51·0	8,307	39	46·9	966	1— 8
Dingli	39·5	883	5	56·6	890	3	34·4	135	1— 6
Zebbug	53·5	5,952	15	25·2	6,037	33	54·6	552	1—11
Siggieui	26·9	3,525	5	14·1	3,569	5	14·0	300	1—12
Lia, Attard and Balzan	73·0	4,910	87	177·2	4,954	31	62·5	723	1— 7
Naxaro	31·7	3,743	15	40·0	3,820	29	75·9	153	1—25
Musta	40·9	6,305	15	23·7	6,454	10	15·5	678	1— 9
Gargar	22·9	1,476	5	33·8	1,503	6	39·9	239	1— 6
Mellieha	11·6	2,693	4	14·8	2,778	3	10·8	355	1— 8
Luca	7·8	3,971	13	32·7	3,980	14	35·1	442	1— 9
Zurrico	24·2	4,005	—	—	4,067	13	31·9	641	1— 6
Safi	31·4	405	—	—	414	—	—	136	1— 3
Crendi	19·9	1,470	—	—	1,489	5	33·5	158	1— 9
Micabiba	19·3	1,374	—	—	1,402	2	14·2	51	1—27
Chircop	22·6	728	1	13·7	742	—	—	157	1— 5
Zeitun	29·8	8,601	14	16·2	8,732	24	27·4	306	1—28
Axiak	22·1	1,688	1	5·9	1,713	4	23·3	442	1— 4
Gudia	26·3	1,245	2	16·0	1,261	1	7·9	360	1— 3
	33·4	61,200	224	36·6	62,112	222	35·7		
Public institutions	—	—	22	—	—	25	—		
Not stated	—	—	—	—	—	13	—		
Totals for Malta	32·0	180,639	688	38·0	183,231	774	42·2	17,110	1—10·7

* 'Reports of the Commission,' Part II, p. 18.

attention which has been paid to the disease during the last three years having caused more cases to be diagnosed and notified. It has to be remembered that blood examinations are not a routine proceeding in connection with civil cases, the diagnosis being mostly determined by the clinical features of the cases.

3. That the surburban districts have always shown a greater number of cases than the urban districts. Several points arise for consideration in this connection:

(*a*) Nearly all the places included under "suburban areas" are now drained, so that absence of drainage does not explain the heavier incidence.

(*b*) The disease does not show any marked preference for places having an indifferent sanitary reputation. During the two years July 1, 1904, to June 30, 1906, Sliema, which is a newly built suburb, well situated, with good streets and houses, good drainage, a satisfactory water supply, and containing the residences of a large proportion of well-to-do people, has been marked among the suburban districts by the highest prevalence of the disease. The sanitary conditions in Sliema are in marked contrast to the conditions obtaining in Misida, and yet the prevalence of the disease is about the same in the two places. Again, Birchircara and Curmi have frequently been contrasted, the former having a good reputation from a sanitary point of view, but a bad reputation as regards prevalence of Mediterranean Fever, while the conditions are the exact reverse in the case of Curmi. A possible explanation may be that there is a greater consumption of goats' milk in Birchircara than in Curmi. Table III shows that, with practically equal populations, there are nearly three times the number of goats in Birchircara than in Curmi; and, further, Curmi contains a much larger proportion of very poor people, and the poor are not large consumers of milk, as it is for them an expensive commodity.

(*c*) Although it often appears that density of population seems to be attended by marked incidence of Mediterranean Fever, yet this is far from being always the case. It will be observed (Table III) that Zebbug, which is one of the least densely populated places, displays more than average prevalence during the 10 years' period 1894 to 1903, and also in the second of the two years under consideration, although it was under the average in the first of these years. In the urban areas the same is observed. Floriana, which is much more open than Valletta and less densely peopled, shows more than three times the incidence of the latter for the decennial period and for the two years under special consideration. The Manderaggio, which is one of the poorest and most densely populated parts of Valletta, with a population of about 3000, and is also one of the worst parts from a sanitary standpoint, has only had five cases of Mediterranean Fever reported from it during the two years, two in 1904 and three in 1905.

3. *The Relation of Goats to the Incidence of the Disease.*

With a view to see whether any relation existed between the number of goats and the incidence of the disease in towns and villages, a special enumeration of the goats in Malta was made at the end of June, 1906. This was rendered possible by the fact that every goat owner has to register, at regular intervals, with the police, information regarding the number of goats he possesses. The figures are given in Table III, but we can draw no exact deductions of a general kind from the information so obtained. It is of interest to note, however, that a very large number of goats are kept in the suburban districts, which, as already pointed out, are also marked by the greatest incidence of Mediterranean Fever. It is from these suburban herds that the milk supplies of Valletta, Floriana, Sliema, and the three cities are chiefly obtained. Hamrun, Birchircara, and Misida provide the supplies for Valletta, Floriana, and Sliema, while the Zabbar, Tarxien, and Paula goats supply Cospicua, Vittoriosa, and Senglea.

Exportation of Goats from Malta.—A large number of goats are exported from Malta each year, chiefly to Sicily and North Africa. In the two years from July 1, 1904, to June 30, 1906, the numbers exported were 1911 goats, 20 kids, and seven billy goats. In this number are included the goats shipped in the s.s. "Joshua Nicholson," which, as related elsewhere, led to an outbreak of Mediterranean Fever on that ship and to the occurrence of cases in the United States. It is evident, therefore, that the exportation of goats is attended by the danger of the spread of the disease in the places to which the animals are consigned. As already mentioned in the military part of this report, Horrocks has pointed out that in 1883, when Mediterranean Fever was prevalent in Gibraltar, practically all the goats on the Rock were Maltese, and that regular shipments of goats from Malta to Gibraltar took place at that time. Shortly after 1883 there was an increase in the cost of shipment, which led to the stoppage of the importation of goats from Malta on a large scale and, coincident with this, the disease has practically disappeared from Gibraltar.

Milk in Relation to Incidence among the Civil Population.—The milk supply of the civil population is goats' milk, and it is generally used unboiled. In some cases the milk is obtained regularly from the same goat-herd; in others, and this is very common, the milk is bought from any passing herd, while others again keep one or sometimes two goats of their own. We have been informed that many poor people do not use milk at all except when it is required for cases of sickness.

During the last two years, special enquiries were made by the sanitary inspectors with regard to the source of the milk used by patients notified as suffering from Mediterranean Fever, and the

results are as follows. Of the 1462 cases notified, no particulars could be obtained in 68 instances. In the remaining 1394 cases, goats' milk was used by 1318 of the patients, condensed milk in five instances, while there is a history of no milk in any form in the remaining 71 cases.

Table III shows that Lia, Attard and Balzan usually exhibit a heavy prevalence of the disease. Two hundred and three of the goats at Lia and Balzan were examined in 1905, and 31 were found to be infected. The Chief Government Medical Officer, Dr. Caruana Scicluna, has provided a good piece of negative evidence in connection with the Institute of the Good Shepherd at Balzan. He states that there has not been a single case of fever amongst the 200 inmates of this institution for many years past. The goats supplying the milk are the property of the Institute, and when examined they have been found to be uninfected.

Further details with regard to goats' milk as a factor in the causation of Mediterranean Fever amongst the civil population are given in the paper contributed by Dr. A. Critien, of the Public Health Department, Malta, p. 235.

Control of Goats and of the Milk Supply.—It follows, from a consideration of the dangers of infected goats' milk, that the most imperative need is the regulation of the goat traffic and proper control of the milk supply. The goats should be kept outside the towns, and suitable arrangements made for bringing the milk in to be sold. In Malta it is urged that the poor people prefer to have the goats brought to their door and there milked, because they can then see what they are getting, and there is less chance of adulteration. But surely this is a prejudice that can be overcome. In no other civilised community is the source of the supply brought to the consumer's door to be milked, and there is no greater likelihood of adulterated milk being vended in Malta than exists in every other place of importance in the world. Everyone who is familiar with the streets of Valletta is also familiar with the smell of these streets. The objectionable smells are entirely due to the perambulation of the streets by herds of goats. In every gutter are to be seen collections of goats' urine, and these and the goats themselves are the causes of the foul odours. A great object-lesson was furnished to the inhabitants of Valletta during the fortnight that the goat-herds' strike lasted. There were no goats in the town during that period, the streets were clean, and the bad smells disappeared completely. The extraordinary improvement in the state of the streets was the subject of common remark at the time. As soon as the goats returned, the smells became as bad as ever. There can be no doubt about the fact that if the goats were excluded from the streets, Valletta would be as clean and pleasant as any well-run town in Europe. Until the goats are removed the condition of the

streets must continue to be a reproach, and Valletta must be regarded as being content with a sanitary standard which is far below what it might be.

Improved Sanitation.—Otherwise, considerable improvements have been made during the last two years. Young men are being sent to England to be trained in the duties of sanitary inspectors. Very fine public urinals have been erected in different parts of Valletta. In company with the Director of Public Works, we went over the entire drainage system, including the pumping arrangements at Sliema, the flushing tank at Lower St. Elmo, and with Dr. Zammit we visited the sewage outfall to the sea beyond Ricasoli. We also saw the new Shone installation for dealing with the low-level drainage of the low-lying parts surrounding the upper end of the Grand Harbour and along its Valletta side. The work in connection with this new system was almost completed, but was not yet in use when we left Malta at the end of September. There is another large project in course of construction, which has for its object the flushing of the entire sewerage system of Malta with sea water, including outlying towns and villages as well as Valletta and the three Cities. The main supply tank has been excavated, and to this sea water will be pumped, and from it the flushing water will be distributed by gravitation. It will be a considerable time before the pumping plant is installed, and it will necessarily take time to connect up to the various lines of drainage. When completed, it will be a sanitary advance of great importance. If, at the same time, it were possible to combine with it a free supply of water for flushing from the houses through the house drains into the main drains, there would be little fault to find with the sewerage of Malta, although there would be still room for great improvement in regard to house fitments and connections.

4. *Goats' Milk as a Factor in the Causation of Mediterranean Fever amongst the Civil Population.*

By Dr. A. Critien, Public Health Department, Malta.

The recovery of *Micrococcus melitensis* from goats' milk has very naturally directed the epidemiologist's activity to a new line of investigation which, if attended with positive results, must put Mediterranean Fever in a great measure within the reach of preventive medicine. The facts collected and the work done in this direction, during the last few months, have established that infected milk, though not the only channel, plays a very important part in the transmission of the disease. The following few observations, abstracted from the results of personal inquiries into 245 notified cases of Mediterranean Fever, are therefore intended only as a small contribution towards the study of this question.

The milk used in Malta is goats' milk; the number of milch cows in

the island is too small to be taken into consideration. The consumption of milk has during the last few years been steadily increasing, both in town and in the country; and though in the villages it is far from rare to find persons who absolutely refuse to drink milk, in the towns and suburbs such perhaps are only exceptionally met with. Milk is not boiled; this precaution has hitherto been considered superfluous, because the Maltese goat has never been known to suffer naturally from tuberculosis; bovine tuberculosis, it must be remembered, has been mainly responsible for the continental routine of milk sterilisation by boiling.

Milk is generally drunk with tea or coffee, the proportion of milk varying with the means of the particular individual. Weak digestive organs, the result of higher civilisation and of a harder struggle for life, have for obvious reasons contributed to increase the consumption of fresh milk, an item, moreover, which enters largely into the diet of the younger members of the population. Some of the foregoing statements are supported by figures shown in Table "A," from which we see that the number of goats in Malta has doubled during the last 15 years; but the population has not increased in the same proportion; whilst in 1891 there was one goat for every 17 persons, now there is one for every 10.

Table A.—Malta.

Year.	Civil population.	Number of milch goats.	Proportion of goats to persons.
1891......	146,484	8,724	1 in 17
1901......	164,952	10,944	1 in 15
1906......	183,231	17,488	1 in 10

Out of 511 cases of fever notified as Mediterranean Fever from the beginning of January to the middle of August, 1906, I have been able to inspect premises where 245 cases had occurred and to interview either the patients themselves or some relative.

The information collected with regard to the use of milk may be tabulated as follows:—

Table B.

No milk.	Condensed milk.	Cows' milk, boiled.	Goats' milk, boiled.	Goats' milk, unboiled, by itself.	Goats' milk, unboiled, with tea.	Goats' milk, how used not ascertained.
50	5	8	5	43	103	36
58			187			

The proportion of fever patients who are milk-users to non-milk or other milk-users may, therefore, be calculated as 3 to 1. As my investigation was not limited to fever cases in the towns, but extended to cases in the villages and suburbs, this proportion may be regarded to obtain generally amongst all persons suffering from the fever in Malta.

Out of 315 cases of fever notified from August to December, 1905, 26 occurred in premises where one or more goats were kept and, with few exceptions, had supplied milk to the patients before illness. Out of the 511 cases notified between January and August, 1906, 67 occurred under similar circumstances, 30 occurring amongst herdsmen. The 67 cases were distributed as follows:—

			Cases.
50 dwellings	with	1 case in each.........	50
3	„	3 cases in each	9
2	„	4 „	8
		Total	67

Of the 26 cases in the August to December, 1905, series, nine were amongst herdsmen. Ten cases notified from the village of Lia during that period may be thus classified:—

Three in one herdsman's family.

Four in households supplied with milk by this herdsman.

Three milk supply not ascertained.

Altogether seven members of this herdsman's family were down with fever during 1905.

Some of the information collected about 25 of the 67 cases mentioned above is given in Table "C." Those instances only have have been recorded in which the goat or goats had been penned in the same house or compound where the cases occurred.

In connection with 17 of these, the milk supply was examined bacteriologically. I regret that such a research, owing to stress of other work, could not be extended to all the cases. Three of these 17 cases occurred in the same house, so that the number of instances in which milk supply was found to react to Zammit's test may be put down as 7 out of 15, and the *Micrococcus melitensis* was isolated in 3.

The milk supply was examined in connection with another series of 25 cases which had been regularly supplied, previously to their illness, with milk by one or more milk herds. Results are given in Table "D." This is by no means a selected series, although a short one. The difficulty met with in trying to identify the milk supply in the majority of cases personally investigated has so far frustrated my best efforts. As the milk is hawked in the streets, many persons get their milk from the first milkman who happens to be about at the time milk

Table C.—Twenty-five Cases of Mediterranean Fever in Premises where one or more Goats were kept before Illness.

Initials of patients.	Sex.	Age.	First attack.	First case in premises.	Goats in premises.	Milk.	Patient's reaction.	Examination of milk.
P. A.	M.	3	Yes	Yes	Herd	Goats'	+	Not examined.
M. P.	F.	30	„	„	„	„	+	„
P. G.	F.	37	„	„	2 goats	„	+	„
G. F.	M.	56	„	?	1 goat	„	+	Examined and plated twice; reacted within 2 hours; no *Micrococcus melitensis* recovered
G. F.	F.	24	„	Yes	„	Not used	+	Examined twice, no reaction
C. D.	M.	33	„	„	„	Goats'	Tested once	Examined once, no reaction
C. M.	F.	35	„	„	Herd	Not used	„	Not examined
J. C.	M.	21	„	?	2 goats	Goats' with tea	+	Examined once; 1 reacted within 2 hours; plated; no *Micrococcus melitensis* recovered
G. G.	M.	50	„	Yes	Herd	Not used	+	Of 6 goats, 1 secretes *Micrococcus melitensis*
G. C.	F.	13	„	„	1 goat	Goats' with coffee	+	Examined once; no reaction
G. P.	F.	57	„	No	2 goats	„	+	Examined three times; 1 reacted within 2 hours; no *Micrococcus melitensis* recovered

In same house—								
N. B.	F.	45	„	Yes	Herd	Goats' by itself	?	Not examined
C. B.	F.	15	„	„	„	Fresh	?	„
G. E.	M.	36	„	„	1 goat	Goats'	?	Examined twice; no reaction
In same house—								
A. C.	M.	39	„	„	„	„	?	Examined once; reacted within 2 hours; no *Micrococcus melitensis* recovered
M. C.	F.	38	„	„	„	„	+	
S. C.	M.	18	„	„	1 sheep	„	?	
M. B.	F.	60	„	„	1 goat, 1 sheep	Goats' by itself, fresh	+	Examined once; no reaction within 2 hours
R. V.	F.	22	„	„	1 goat	Not used	+	„ „
V. S.	F.	62	„	„	Herd	Goats', fresh by itself	+	3 goats out of 34 reacted; 1 yielded *Micrococcus melitensis*
C. C.	M.	20	„	No	„	„	+	10 goats out of 18 examined; no reaction
S. B.	M.	48	„	Yes	1 goat	Not used	+	Examined twice: reacted within 2 hours; *Micrococcus melitensis* recovered
C. M.	M.	18	„	„	Herd	Goats'	+	Not used
S. C.	M.	36	„	„	2 goats	Goats' with coffee	+	Examined twice; no reaction
N. M.	M.	64	„	,	1 goat, 4 sheep	„	+	Not examined

Table D.—Bacteriological Examination of Milk Supply in connection with 25 Cases of Mediterranean Fever.

Initials of patients.	Sex.	Age.	First attack.	First case in premises.	Milk used.	Patient's reaction.	Examination of milk supply.
N. C.	M.	20	Yes	Yes	Goats' unboiled	+	
C. F.	F.	15	”	”	”	?	Common milk supply
M. A. B.	F.	56	Second attack	No	”	+	
In same house—							
G. B.	M.	½	Yes	Yes	”	+	
C. B.	F.	?	”	No	”	+	36 goats' milk examined; 8 reacted within 2 hours; *Micrococcus melitensis* recovered from 2
C. P.	F.	15	”	Yes	Goats' unboiled with tea	+	
P. B.	M.	29	”	”	Goats' unboiled by itself	+	
A. G.	F.	25	”	”	”	+	
V. B.	M.	51	Second attack	No	Goats' unboiled with tea	+	Common milk supply; 6 goats' milk examined; *Micrococcus melitensis* recovered from 2
E. C.	F.	38	Yes	Yes	Goats' unboiled by itself	+	
G. Z.	F.	29	”	”	”	+	9 goats' milk examined; 2 reacted within 2 hours; *Micrococcus melitensis* not recovered
M. F.	F.	41	”	”	”	+	24 goats' milk examined; *Micrococcus melitensis* recovered from 4; 6 goats' milk examined; *Micrococcus melitensis* recovered from 1
C. Z.	F.	40	”	”	”	+	1 goat's milk examined; no reaction
C. F.	F.	40	”	”	”	+	13 goats' milk examined; *Micrococcus melitensis* recovered from 6
G. C.	F.	13	”	”	”	+	15 goats' milk examined; none reacted

S. F.	M.	43	"	"	"	?	6 goats' milk examined; *Micrococcus melitensis* recovered from 1
C. B.	M.	21	"	"	"	+	2 goats' milk examined; no reaction
In same house—							
A. C.	F.	25	Yes	Yes	"	+	
M. C.	F.	18	"	"	"	+	
E. C.	M.	26	"	"	Goats' unboiled with tea	+	7 goats' milk examined; 2 reacted; *Micrococcus melitensis* recovered from 2
L. C.	F.	15	"	"	"	+	
W. C.	M.	28	"	"	"	+	
In same house—							
N. G.	M.	18	"	"	Goats' unboiled	+	
N. S.	M.	20	"	"	"	+	20 goats' milk examined; 1 reacted; *Micrococcus melitensis* not recovered
N. O. R.	M.	20	"	"	"	+	

Table E.—Seven Cases of Mediterranean Fever and Result of Bacteriological Examination of Milk Supply in connection with same.

Initials of patients.	Sex.	Age.	First attack.	First case in premises.	Milk used.	Patient's reaction.	Examination of milk supply.
G. M.	M.	43	Yes	No	Goat's	?	1 goat owned by patient. No reaction
A. V.	F.	5½	"	Yes	"	?	1 goat owned by patient. No reaction. Other goats had been supplying milk. Not examined
M. P.	F.	40	"	No	"	+	2 goats owned by patients. No reaction
G. D.	M.	?	"	Yes	"	?	
F. V.	F.	54	"	"	"	+	2 goats, 1 reacted within 2 hours; *Micrococcus melitensis* not recovered
G. V.	M.	17	"	No	"	?	
C. C.	F.	45	"	Yes	"	+	1 goat owned by patient. No reaction

is required. Many again, who get it regularly from the same man, cannot remember anything more than his Christian name. Others are very reticent, because they cannot understand why the milk they have been consuming for months without any ill effects should be suspected of being the cause of Mediterranean Fever.

Four groups of cases shown in Table "D" had a common milk supply. Two cases in the first group occurred in the same dwelling; the third group—five cases—had also a common residence, and the same was the case as regards the fourth group. In six instances the milk supply was found to be actually infected, viz., one or more goats were at the time excreting *Micrococcus melitensis* with their milk; in two instances one or more goats gave Zammit's reaction, but did not yield *Micrococcus melitensis* on the particular day they were examined, and in three instances none of the goats reacted. Six cases out of the first series of eight having a common milk supply occurred in the same street.

The milk supply of another series of seven cases, not included in the 245 investigated by me, was also examined. In one instance Zammit's reaction was obtained (Table "E").

A striking contrast to the heavy incidence of Mediterranean Fever among the general population is offered by the absence of the disease in communities that do not use milk. The Civil Prison, with its average daily population of about 185 persons of different sexes and ages, is an example. No milk under any form is allowed to the prisoners unless they are on the sick list. The average daily sick for the year 1905—6 was 24·9. Under these circumstances, although the prison may be said to form part of Paola, a village which is by no means free from Mediterranean Fever, only one case has been recorded during many years. This case reported sick on May 8, 1906; his blood, which was negative on the 16th of the same month, reacted well in 1 in 40 against *Micrococcus melitensis* on June 6 when he first sickened. Less than a month had elapsed since his commitment, and if he had not been detained some time at Gozo, the sister island, before his transfer to the Malta gaol, one would have been quite justified in doubting whether the disease had been contracted in prison. Another case, notified from the same prison in 1903, must have been infected when at large, because he had only been in prison three days when he developed Mediterranean Fever. So that, except for the case previously mentioned, the disease has been unknown among this community. Both the present medical officer and his predecessor agree in stating that during the time they have had medical charge of the prisoners—a period of nine years—no other cases of Mediterranean Fever have come under their observation. The only channel of infection that has been inoperative all through these years is goats' milk. Dust contaminated with infected urine must have been blown many a time from the streets of Paola into the prisoners' cells,

and mosquitoes, another suspected carrier of infection, cannot have found it difficult to fly from the village houses to the prison compound. One cannot, therefore, help connecting the absence of Mediterranean Fever with the absence of milk from the prisoners' dietary.

Human milk, like goats' milk, agglutinates the specific micrococcus, if obtained from Mediterranean Fever patients. The highest dilution attended with positive results has been, in one of my cases, 1 in 150 within half an hour. It does not appear that human milk is likely to react in the same high dilutions as some blood sera. Although I have not been successful in isolating *Micrococcus melitensis* from human milk, its transmission from mother to child, through this channel, has been actually demonstrated by Major McNaught, R.A.M.C., so that the danger of the disease being thus conveyed must not be lost sight of.

The quantity of milk obtained from three out of my seven cases was very small (one to two drops), and no plating was, therefore, attempted; the plates prepared from the rest were so overgrown with other bacteria that the identification of *Micrococcus melitensis* was rendered impossible.

A few notes about the cases will not, I hope, be found superfluous.

1. M. P., aged 30. Baby 4 months old. Fever began a few days after confinement. Milk thin and serous; it reacts within half an hour in a dilution of 1 in 20. Blood reacts well. Specimen of baby's blood could not be obtained.

2. E. C., aged 30. Baby 3 months old. Fever began before confinement. Breast almost dry, one or two drops of very thin fluid obtained: it reacts within half an hour up to 1 in 80. Blood reacts 1 in 40 at once; higher dilutions not tried.

3. G. F., aged 24. Confined three weeks before; baby weaned. Breast drying up. Few drops of curdy fluid obtained; it reacts up to 1 in 40 at once. Blood reacts well in same dilution; higher dilutions not tried.

4. C. Z., aged 40. Onset of fever one month after childbirth; nursing baby 4 months old. Milk has diminished in quantity and is very thin. It reacts only up to 1 in 20 in half an hour. Mother's blood reacts well in 1 in 40. Baby's blood does not react; only 1 in 10 tried. Milk plated; no *Micrococcus melitensis* recovered.

5. C. F., aged 21. Fever started one month before confinement. Baby was given out to nurse, and is now 2 months old. Milk reacts readily up to 1 in 150 in half an hour. Blood reacts well 1 in 40. A few drops of milk plated. No *Micrococcus melitensis* recovered.

6. P. G., aged 24. She is nursing baby 9 months old. Fever began three months after confinement. Blood reacts well. Milk positive up to 1 in 20 in half an hour. Plated; no *Micrococcus melitensis* recovered. Specimen of blood from baby was refused.

7. C. B., aged 22. Fever began a fortnight after confinement. Baby is now 4 months old. Milk reacts only 1 in 5 in half an hour. Blood reacts at once in 1 in 40. Specimen of baby's blood was refused. Milk plated; no *Micrococcus melitensis* recovered.

General Summary.

By Major T. McCulloch, M.B., Major J. C. Weir, M.B., Royal Army Medical Corps; and Staff-Surgeon F. A. H. Clayton, M.D., Royal Navy.

i. The incubation period.
ii. A critical examination of the naval, military, and civil observations.
iii. Recommendations.

i. The Incubation Period.

In the previous epidemiological reports it has been customary to discuss the question of incubation period at the commencement, in order to fix working data. This course has not been followed on the present occasion, as in the investigation of cases it was found that to keep rigidly to any fixed period was often impossible. In a very considerable proportion of the individual cases investigated there has been a sort of preliminary canter of a few days' pyrexia, but without agglutination reaction, followed later by a definite appearance of Mediterranean Fever. In many other cases the patients have felt vaguely ill for months. Again, many patients, admitted to hospital for other illness, have exhibited towards the latter part of their stay a few days of febrile and other symptoms, with no very obvious cause, and shortly after leaving hospital they developed Mediterranean Fever. Similarly, many of those who developed the disease while still resident showed the same history of preceding slight febrile attack. All this points to the very insidious nature of the onset of this disease and to the difficulties encountered in fixing the limits of an incubation period, and in saying whether an outburst of symptoms is, or is not, the first manifestation of the disease. Nothing would have answered our purpose better than to have been in a position to apply a definite period of incubation to the date of onset of symptoms, and so fix with some degree of certainty the time within which infection must necessarily have occurred. Much suggestive information on this point was obtained in the course of our work and from the study of statistical data, particularly data relating to the interval between residence in hospital for other illness and onset of symptoms of Mediterranean Fever, and in regard to the onset of illness occurring in cases after the men had left Malta.

Accidental or purposive laboratory inoculations appear to show an incubation period varying between five and 16 days. Dr. Johnstone gives his views with regard to the matter in the following words:—"It may, however, be provisionally stated that the data available tend in some degree to suggest that the period of incubation of Mediterranean

Fever ranges about a period of 14 days." Lieut.-Colonel Davies considers that there is a sufficient agreement in the results of animal experiments to lead to the supposition, which is on other grounds reasonable, that with infection by inoculation the incubation period is shorter than by ingestion into the alimentary canal; and this appears to be borne out by the results of the feeding experiments this year, no monkey so experimented upon having had an incubation period of less than 12 days. In connection with this subject, it is of interest to note that, this year, when the infected food was limited to one day's feeding, the appearance of the agglutination reaction varied from 12 to 21 days, as opposed to 14 to 76 days obtained last year as the results of feeding experiments in which infected food was given over many days. It has been suggested by the laboratory members of this year's working party that a probable explanation of the delay in the appearance of the agglutination reaction observed in last year's experiments would be that repeated doses of *Micrococcus melitensis* produced a negative phase, which lasted until the cessation of feeding or an absence of the micrococcus permitted the formation of the specific agglutinins. Viewed from the epidemiological standpoint, the same reasoning may possibly explain the very late appearance of the agglutination reaction in certain typical and atypical cases of the disease, in which milk has been ingested over considerable periods, and who, therefore, may have been receiving repeated quantities of *Micrococcus melitensis*. We associate ourselves with the view expressed by Lieut.-Colonel Davies, in Part IV of the Commission Reports, to the effect that the laboratory limits in all probability require to be considerably extended when the question of human infection in the ordinary way, or ways, has to be dealt with. To this certain of the facts, already recorded, would seem to point, and, in fact, we quote well authenticated cases where the interval between possible exposure to infection and the onset of definite symptoms runs even to months.

The cases which present difficulty in this direction fall under three categories:—

1. Cases presenting suggestive symptoms, but where agglutination is long delayed. These are so comparatively common that further discussion is unnecessary.

2. Cases presenting well marked agglutination reaction, without symptoms and without history of previous illness. Shaw's observations have already shown that the Maltese are sometimes definitely infected by *Micrococcus melitensis* without the slightest apparent effect on their general health. During the blood examinations of healthy English contacts this year (*vide* p. 216), instances were from time to time met with which were strongly suggestive of the occurrence of this condition in their case also. The following are examples:—

Two boys, belonging to the garrison, whose father and mother were

both admitted for Mediterranean Fever in the summer of 1906, gave good serum reactions on repeated examinations. There was no previous history of fever, nor have either of these boys suffered from even a transient illness subsequently. In many instances, during the routine examinations of samples of blood from soldiers who had been in "contact" with a case of the disease, a positive reaction was obtained, and the men were kept under observation, but no departure from their normal state of health was observed (see also examination of bloods of contacts, p. 216).

3. *Latent Infections.*—These are cases in which infection has occurred, but in some of which there is prolonged delay in the appearance of any illness, while in others there are only vague symptoms, insufficient to incapacitate the affected individual. In such latent infections some lowering of vitality, the result of special stress or occurrence of other illness, may determine the onset. The following are illustrative cases:—

(1.) Two of the hospital staff at Bighi were found by Staff-Surgeon Whiteside to react to *Micrococcus melitensis*, one as high as 1 in 300, without ever having been on the sick list, although in both cases there was a history of malaise during the previous summer, months before the examination. The man showing the reaction in lower dilutions subsequently developed an attack of Mediterranean Fever, the other did not.

(2.) W. H. W., ordinary seaman, of the "Diana," was in Bighi Hospital from May 31 to July 12, 1905, with a fractured tibia. After July 27 he suffered from occasional headaches. His ship left Malta a week after his discharge to her from hospital, and remained either at Candia or Suda Bay, with the exception of six days at Phalerum Bay, until November 15, when she returned to Malta and stayed until December 18. During September, while engaged in stokers' training class, very trying work indeed, the patient had felt unwell, but did not go on the list or make any complaint. The ship left Malta again on December 18 for Port Said, where she remained until January 18, and then proceeded *viâ* Suez and Port Sudan to Akaba in connection with the Turkish frontier dispute, arriving there on February 18 and remaining till May 22, a period of three months. Here she lay off a practically uninhabited coast, with which there was no communication, and her only intercourse with the outside world was through a weekly steamer which brought provisions. On May 2, 72 days after arrival here, the patient was noted to be looking ill, and although he made no complaint he was placed on the list, and was found to have pyrexia and to give a good reaction with *Micrococcus melitensis*, which was verified in the Commission laboratory on his arrival in Malta on June 1. He had not been ashore at all since general leave in Malta in December, 1905, and no cases had occurred in the ship since September,

1905. There were practically no mosquitoes at Akaba, and no inhabitants anywhere near. On the ship's return to Malta, all her Maltese, numbering 13, were examined, and one was found to react well, but his urine was plated out with negative result. The opinion of the medical officer of the ship was that the case was an ambulatory one, which had been contracted in Bighi in July, 1905, and although one cannot absolutely exclude the possibility of ship infection, this seems the most probable explanation in view of the history.

Bruce states that cases have occurred in as short a period as six days after arrival in Malta. Johnstone quotes cases occurring eight and 11 days after arrival. In the course of the present enquiry the following additional cases have been noticed during our examination of army records :—

	Age.	Total service.	Service in Malta.
		years.	
1. Private D., 3rd K.O. Yorkshire Light Infantry ...	42	13	1 week
2. Private J., 1st Royal Garrison Regiment............	40	6/12	1 „
3. Drummer D., 5th Royal Munster Fusiliers	12	1	16 days
4. Private O., 2nd Loyal N. Lancashire Regiment ...	19	11/12	2 weeks
5. Private P., 3rd Royal Garrison Regiment	34	3/12	2 „
6. Private T., 3rd Royal Garrison Regiment	35	7/12	3 „
7. Gunner J., 63rd Company, Royal Garrison Artillery	19	1	2 „
8. Private McG., 1st Royal Dublin Fusiliers	—	—	11 days

Case 2 was admitted for Mediterranean Fever, but gave a negative reaction up to 24 days after admission. Case 5 was admitted for fever, but gave a negative reaction 13 days after admission and no positive reaction is recorded until over two months later. Case 7 gave a positive reaction 10 days after admission. The other cases gave early reactions.

The longest interval between apparent exposure to infection and appearance of symptoms that came under Johnstone's observation, was the case recorded by Bassett-Smith, in which the interval was apparently two months. In the following case the possibilities of exposure to infection after the man had left Malta were practically nil, and the interval, as will be seen, was over three months.

R. H., stoker, H.M.S. "Sentinel," was a patient in Bighi Hospital from January 29 to February 28, 1906, with syphilis. It was a mild case of syphilis, with chancre and secondary symptoms. No record of temperature. During his stay there he had no symptoms in any way suggestive of Mediterranean Fever, nor was there any previous fever history. He had three pints of milk daily for 26 days, and it was stated that he was quite well on return to his ship. H.M.S. "Sentinel" left Malta on March 2. On the passage home, the ship arrived at Gibraltar on the 5th and remained

there till March 20, arriving at Plymouth on the 25th. This man did not go ashore either at Malta or Gibraltar. He had a feverish attack, starting on June 6, with pains in joints and swelling of knees and wrists, but he had recovered by June 16 and returned to duty. During the manœuvres in June the ship called again at Gibraltar, but only coaled, and sailed at once, and was not again within the limits o :the Mediterranean station. This was on June 30, after the patient had had the feverish attack referred to. A recurrence of symptoms occurred on July 5, when he was sent to Plymouth Hospital, where he gave a positive agglutination reaction up to 1 in 500, and he died on July 18.

The following cases, bearing on the same point, were kindly provided from the records of the home naval hospitals:

Mr. C. F. returned from the China station, probably calling at Malta, and two months after return was attacked by illness, which, on admission to Plymouth Hospital in August, 1905, proved to be Mediterranean Fever.

Commander W. F. B. left Malta at the end of March, and was placed on the sick list on May 11, but he first began to feel ill about the middle of April.

Mr. B. B. called at Malta from June 15 to 20, on his way home from China in the "Andromeda." The onset of his attack, which was stated to be the first attack, and to be acute, was on August 20. His blood reacted at Haslar up to 1 in 40.

W. H. had returned from the Mediterranean six months previous to the onset of his attack on November 16, 1905, at Chatham.

All these cases are reported to be first attacks.

The following cases were obtained from military records :—

The information from Egypt was kindly furnished by the Principal Medical Officer of that command. We are indebted to Lieut.-Colonel J. B. Wilson, R.A.M.C., for the particulars regarding the cases occurring in Alexandria, in 1905 and 1906, amongst men of regiments which had recently arrived from Malta. Lieut.-Colonel Wilson had made special notes in these cases for the purpose of throwing light on the incubation period, and he considers it very improbable that the disease in any of the cases could have been contracted in Alexandria.

It may be urged that the sequence of cases indicates the possibility of contact as a factor, and this possibility has already been mentioned (p. 148) in connection with the cases which occurred in 1905, at Cairo, amongst the men of the 1st Battalion King's Royal Rifles, some months after the arrival of the regiment there from Malta. As in the Cairo cases, so in the Alexandria cases, the disease only appeared in men who had previously served in Malta. Against the contact view in the Alexandria cases it may be further stated, however, that the distribution was a scattered one, involving five companies out of eight, and the officers' mess, in the 18 cases belonging to the Dublin Fusiliers; and four companies and the officers' mess in the six cases belonging to the Worcestershire Regiment.

It may be noted too that, as Cases 1 and 2 in the Dublin Fusiliers list were in hospital before the arrival of any of the other men

attacked in Alexandria, there is little possibility that they were the source of infection for the cases that occurred subsequently.

Number.	Date of arrival in Alexandria.	Date of onset of symptoms.	Interval between leaving Malta and onset.	Remarks.
1st Royal Dublin Fusiliers—			days.	
1	10/10/05	20/10/05	14	
2	10/10/05	23/10/05	17	
3	19/11/05	4/12/05	20	
4	"	10/12/05	26	
5	"	"	"	
6	"	11/12/05	27	
7	"	20/12/05	36	
8	"	22/12/05	38	
9	"	23/12/05	39	
10	"	30/12/05	46	
11	"	6/ 1/06	53	
12	"	7/ 1/06	54	
13	"	26/ 1/06	72	
14	"	31/ 1/06	77	
15	"	12/ 2/06	91	
16	"	Unknown	—	Admitted to sick list 60 days after leaving Malta
17	"	"	—	Admitted to hospital 83 days after leaving Malta
18	"	22/11/05	8	First admitted for rheumatic fever, but this was probably an error. No blood examination was made until February 12, 1906, when he was again admitted and Mediterranean fever was diagnosed
4th Worcestershire Regiment—				
19	11/ 5/06	14/ 5/06	7	
20	"	16/ 5/06	9	
21	"	17/ 5/06	10	
22	"	18/ 5/06	11	
23	"	21/ 5/06	14	
24	"	8/ 6/06	28	

It will be further observed that there was a constant sequence of cases in the Dublin Fusiliers, up to 91 days after their departure from Malta. Then, notwithstanding the advent of the hot weather, the disease in this regiment entirely ceased.

Stronger still is the fact, that there followed an entire absence of Mediterranean Fever from the garrison of Alexandria until the arrival

of the Worcestershire Regiment from Malta, when the disease again made its appearance, but only among the men of that particular regiment.

For the following cases we are indebted to Lieut.-Colonel Jennings, Royal Army Medical Corps, Malta.

A party of two ladies and a maid, travelling in the Mediterranean, were on a steamer that went ashore at Malta on April 21, 1906, and they left Malta for England on May 7. One of the ladies developed Mediterranean Fever on May 9, and the attack proved one of great severity. In this case the incubation period may have been anything up to 18 days. The second lady, who was companion to the first, was attacked eight days later, her illness dating from May 17, with an incubation period, therefore, of any time up to 26 days. The maid, on arrival in England, went to her home for a holiday on May 18, and she was attacked on June 6, or just about a month after leaving Malta. The doctor of the steamer, who was in Malta during the same period, was also attacked, and the onset of his illness dates from May 25; and his attack was also one of great severity. The diagnosis in the first and fourth of these cases was supported by positive agglutination reactions.

ii. A Critical Examination of the Naval, Military and Civil Observations.

The important facts with regard to the ways in which the specific micrococci find their way out of the bodies of infected men, or of infected animals, may be summed up as follows. Examinations of the breath, saliva, sweat and scrapings from the skin have yielded negative results. The bowel discharges are still in the doubtful category. The micrococci have been recovered from the blood, and also from blood ingested by biting insects. The main paths, however, are in milk and in the urine, and of these the first is by far the more important.

The possible paths of infection which have been advanced in discussions relating to the etiology of Mediterranean Fever include food stuffs, and particularly milk and its products, contact, mosquitoes or other biting insects, infected dust, latrine and drain infection, water, etc.

Milk.—The main facts which have been established with regard to the infectivity of milk are:—

1. That a very large percentage of the goats in Malta are infected.
2. That the milk of a large proportion of the infected goats has been found to contain the specific micro-organism, and often in enormous numbers.
3. That the quantities present show great variations from time to

time, and no obvious relation has been observed to temperature or to season of the year, either with regard to abnormal presence of *Micrococcus melitensis*, or to their disappearance from an infected milk.

4. That monkeys and other animals fed on naturally infected milk have contracted the disease as a result.

5. That, in addition to the evidence relating to Malta, the disease has been found to be associated with goats, both in India and the Orange River Colony; and in India the specific organism has been recovered from the milk.

The evidence which we have collected with regard to the part played by the goat, and by milk obtained from it, may be divided into suggestive and direct evidence.

(i.) *Suggestive Evidence.*—1. Mediterranean Fever shows marked variations in incidence in the various barracks, that is to say, there is little or no evidence of persistent or constantly recurring place infection, confined year after year to the same barracks or to the same parts of barracks, but the same cannot be said of hospitals.

2. Although, taken collectively, there is special prevalence of the disease in the hot weather months, it is found on examining the figures for the individual years of the series, 1899 to 1905, that considerable variations occur as to the months that show the highest prevalence. Seasonal prevalence would appear to be an argument against the milk hypothesis, but possible explanations may be, that if milk containing the micrococcus is left standing about, the conditions are more favourable for multiplication of the organism in the hot than in the cold weather; also that cream or milk with fruit, or in ice-creams, etc., are more largely consumed in the hot months; finally, the debilitating influences of the hot season may reasonably be regarded as likely to increase individual susceptibility.

The statements made in 1 and 2 apply also to the occurrence of cases amongst those resident, as patients or otherwise, in the Royal Naval Hospital, Bighi.

3. Every year there is very widespread distribution of cases of Mediterranean Fever in the garrison, no corps or barracks as a rule being exempt, but there are occasional outbursts of epidemicity which do not show any uniform preference for particular months of the year. For instance, the outbreak at Imtarfa in 1899 occurred from May to July, while the epidemic at Floriana in 1903 was at its height from August to October. Table VI, p. 34, shows that in the naval hospital at Bighi the ratio of patients eventually developing the disease constantly differs in all four quarters of the year.

4. In epidemic years the outbreak is usually confined to single units, while nothing more than ordinary prevalence is observed amongst the rest of the garrison. It is important to remember, in this connection, that milk is not a Government supply, and the milk for the different

units and officers' messes was obtained from very various sources, each unit and mess making its own arrangements.

5. One of the most striking statistical facts is that, in proportion to strength, the liability of the military officer to attack is over three times as great as in the case of the man, and very much the same is noted in the navy also. It is also important to observe that soldiers' wives are attacked in the proportion of two to one as compared with the men. Officers and women are more in the way of consuming milk in various forms than the men. The civil statistics do not show the same liability to attack on the part of the female, the relative numbers of notifications being about equal for the two sexes.

6. The disappearance of Mediterranean and simple continued fevers from Gibraltar in the course of the last 20 years has been stated by Horrocks to be coincident with the cessation of importation of goats from Malta and the probable exodus of infected goats from the Rock.

7. During 1906 there has been a remarkable diminution in the prevalence of Mediterranean Fever in both fleet and garrison, and it is significant that, so far as the civil notifications can be relied upon, no corresponding reduction is observed, up to the end of September, as regards the civil population, which are the latest figures in our possession. In both services this has closely followed the preventive measures relating to milk detailed in other parts of this report. So far as the Navy is concerned, the only alteration in preventive measures has been the increased attention paid to the control of the milk supply. The isolation of Mediterranean Fever cases has been carried out for some years past at Bighi. In the garrison, besides the general substitution of condensed for goats' milk, isolation of Mediterranean Fever cases was simultaneously carried out.

8. It is important to observe that isolation of cases was not in itself sufficient in previous years to prevent the frequent occurrence of Mediterranean Fever amongst patients in other parts of the hospital at Bighi.

(ii.) *Direct Evidence.*—1. The history of the s.s. "Joshua Nicholson," detailed in another part of the Report, practically demonstrates the possibility of the infection of man by the ingestion of goats' milk.

2. Enquiries into the milk histories of service patients this year have elicited the fact that, in the large majority of the cases, a direct relation with the use of fresh milk could be traced. The evidence obtained from investigations as to the relative prevalence of Mediterranean Fever amongst the consumers of condensed milk chiefly, and of fresh milk chiefly, have uniformly shown that the chances of infection are much greater in the case of the latter.

3. The examinations of goats made in connection with barracks and other establishments in which Mediterranean Fever was prevalent

have invariably shown the presence of infected goats, and that the milk of some contained the *Micrococcus melitensis.*

4. Dr. Critien's paper gives a number of cases in which Mediterranean Fever occurred in the civil population among consumers of goats' milk which was found on examination to contain the specific organism. A good piece of negative evidence is provided by Dr. Caruana Scicluna's facts relating to the Institute of the Good Shepherd at Balzan, to the effect that when the milk supply is uniformly obtained from healthy goats, no cases of Mediterranean Fever occur.

CONTACT.—Inoculation is a certain way of conveying the disease, as witness the laboratory cases in which it has followed wounds with infected articles. It is, therefore, probable that the disease is sometimes acquired through infected milk, or less often urine, coming in contact with breaches of the surface. Infection of goats and of goatherds is likely to occur in this way. Contact with infected material was also the most probable explanation of the infection of the three R.A.M.C. laboratory attendants, one in 1905 and two in 1906.

As far as the evidence obtained during the investigation of individual cases in barracks is concerned, although the possibility of contact cannot always be excluded, the balance of evidence goes to show that it is probably not a frequent factor. Very few of the men who have come under observation as "contacts" with cases of the disease have had to be subsequently admitted for it, and for the few there are other possible explanations.

One or two instances have come under observation in which persons with no previous history of fever have occupied the same bed as a Mediterranean Fever patient, for weeks together, without contracting the disease by so doing.

The large prevalence of Mediterranean Fever among attendants on the sick would at first sight appear to indicate that contact was a factor of primary importance, but the cessation of cases amongst sick attendants, in both naval and military hospitals in Malta, since the milk change is rather suggestive that contact cannot be a very potent factor. Away from Malta, sick attendants on Mediterranean Fever cases do not contract the disease in the performance of their duties, as, for example, on the hospital ship "Maine," and in Home military and naval hospitals. Nor are any instances known, in Home hospitals, of patients admitted for other ailments contracting the disease through being treated in the same ward with Mediterranean Fever cases. Evidence tending in the same direction is derived from a study of the occupations of the Sick Berth Staff attacked at Bighi.

The possibility of Mediterranean Fever being contracted during sexual intercourse requires mention. The disease has often been

observed to supervene in cases admitted for venereal disease. The *Micrococcus melitensis* has been recovered from the urine of prostitutes and from vaginal swabbings. It is, however, probably not a frequent path of infection, and milk diet in hospital is likely to have been the source of a considerable proportion of these cases in the past.

Biting Insects.—The experimental evidence obtained in 1906 does not lend support to the view that the disease is commonly transmitted to man by the bite of infected mosquitoes. The monkeys experimented upon were each bitten by batches of mosquitoes, which in turn had been separately fed on grossly infected guinea-pigs. That the mosquitoes contained infected blood was determined by the recovery of the *Micrococcus melitensis* from ingested blood and from mosquito droppings. Yet, although the conditions were infinitely more favourable for the conveyance of infection to the monkey than could ever possibly obtain for the infection of human beings by mosquitoes containing blood drawn from a human source, only one very doubtful instance of infection occurred among the 14 monkeys concerning which accurate data are available. This is in marked contrast to the almost universal success which attended the milk feeding experiments.

The epidemiological evidence also tells against the mosquito propagation theory, as will be seen from the following considerations:—

1. The evidence obtained from the investigations of individual cases in 1906 is altogether negative. Answers to questions as to whether a man has or has not been bitten by mosquitoes are possibly of no great value, as many men pay little heed to mosquito bites. From patients who had contracted the disease during the earlier months of the year the answer was commonly in the negative, whereas affirmative replies were frequent in the warmer months.

2. The disease continues to prevail at seasons of the year when mosquitoes are few, or when they seem to be almost absent, as in the earlier months of 1906.

3. There was considerable prevalence of Mediterranean Fever in the garrison during the first six months of 1906, but a large reduction in prevalence occurred in July, August, and September, when mosquitoes were abundant.

4. Cases have come under observation in which the most careful attention was paid to the use of mosquito nets, yet the disease was contracted.

5. The use of mosquito curtains in the Mediterranean Fever wards at Bighi for years did not prevent the occurrence of many cases in the other wards of that hospital.

6. Officers, who as a class make free use of mosquito nets, are three

times more liable to contract the disease than the men, who are not protected from mosquito bites at all.

7. The Camerata married quarters are surrounded by a dense civil population, amongst whom there must be abundant opportunities for mosquitoes to become infected, yet the incidence of Mediterranean Fever is generally light.

8. A study of the cases that have developed in the Royal Naval Hospital at Bighi, where isolation has been the rule for some years, shows that propinquity to the potential sources of infection—*i.e.*, the Mediterranean Fever wards—has had little influence in determining the contraction of the disease, notwithstanding the presence of abundance of mosquitoes.

9. The evidence given in the naval part of this Report, in connection with docking, also argues against mosquito infection.

Sand-flies were much more troublesome than mosquitoes in 1906 in some of the barrack blocks and married quarters. They have a very general distribution in Malta and they suck blood voraciously, their bite causing intense irritation, which leads to scratching, and, especially with children, to the formation of nasty-looking sores. If biting insects can convey the disease, the sand-fly has advantages over the mosquito, as it bites more freely, and nets afford little or no protection. There is no evidence that the disease has been conveyed by it. The same is true of another blood-sucking fly, the *Stomoxys calcitrans*, although it is known to be able to act as the host of the *Micrococcus melitensis* for a few days.

Bugs and fleas cannot be at present incriminated.

FLIES.—The possibility of flies being carriers of the specific micrococci must be remembered. In goat houses and goat pens flies are often present in enormous numbers. They swarm in milking places which are sodden with goats' milk and urine. They are often abundant in latrines, where they may come in contact with infected urine. Arguing from the analogy of enteric fever, the fly may alight on infected matter, and may carry the cocci on its body or legs to food, etc. The fly as a carrier of the disease is discussed in connection with some cases in the West Kent Regiment.

DUST.—The disease has been conveyed to healthy animals by dust, artificially contaminated. The fact that *Micrococcus melitensis* is readily killed by exposure to sunlight, and the rapid dilution that must occur when the dust is blowing about under natural conditions, are against dust being a common factor in the spread of the disease. Localised gross contaminations are possible, as, for example, the surfaces of places in regular use for goat milking, which must necessarily become sodden with milk and urine, and here the possibilities

will be in direct proportion greater. The possibility will be even greater in milking places and goat pens shaded from the sun. The evidence obtained in 1906 is against dust infection.

Drain Emanations.—Hughes favoured the view that emanations from drains and sewers played a large part in the direct causation of this fever. Davies discussed this point at some length (Part IV of the Commission Reports), and we can only add that we have been unable to gather any evidence supporting Hughes' views during our investigation of the cases occurring amongst the troops in 1906.

Foods.—No evidence against foods other than milk has as yet been obtained. It has been found that the *Micrococcus melitensis* retains its virulence in locally-made cheese. Local butter and local cheese are not used by the troops. We have only come across two instances in which local (Gozo) cheese had been eaten.

Water.—*Micrococcus melitensis* has never been found in water under natural conditions. The scattered distribution of the cases of Mediterranean Fever in barracks, which is the rule, is against water-borne infection.

iii. Recommendations.

As the goat is more than probably the primary source of the disease in the vast majority of cases, if not in all cases, and as goats' milk is the common vehicle for the *Micrococcus melitensis*, it follows that preventive measures, to be effective, must be based on sound regulations, framed with a view to stamping out the disease in the goats. In the meanwhile, there should be a vigorous control both of the goat traffic and of milk supplies.

It will not be an easy matter, perhaps, to alter customs which have been in use for many generations, and it may prove impossible to do so otherwise than gradually. There will be much prejudice to be overcome, and even much active opposition on the part of some sections of the public, especially those who make their living by keeping goats and vending milk, and also on the part of many consumers, as it is a common argument in Malta that a large section of the people prefer to have the goats brought to their doors and there milked. Public opinion will have to be educated in the matter, and it will probably be necessary to combine the *suaviter in modo* with the *fortiter in re*.

The local authorities, both civil and belonging to the two services, are fully aware of the facts that goats are sources of the disease, and that infection of milk is both widespread and common.

The Civil measures which are in operation are as follows:—

1. *Notification.*—All cases of fever lasting more than seven days

are to be notified. We have good reasons for believing that many cases of Mediterranean Fever either do not come under observation at all, or that the medical practitioners fail to notify. This requires improvement, and, perhaps, the payment of a small fee.

2. *Blood Examinations.*—The Public Health Department undertake the examination of samples of blood from civil cases, but although facilities have been offered to civil practitioners during the last two years, they have only been made use of in less than a quarter of the cases notified as suffering from Mediterranean Fever. There is also room for further improvement here.

3. *Sanitary Inspection.*—A sanitary inspector visits each case notified and makes special inquiries into, amongst other things, the kind of milk used and its sources, occupation, the sanitary conditions of the premises, contact with previous cases, etc. Inspections of the sanitary conditions of goat houses, etc., also come within the scope of their duties. Some special work is being done by the medical officers of health, as will be observed from Dr. Critien's paper.

4. *Segregation of Goats.*—It is in contemplation to make arrangements for the segregation of reacting goats as a general practice, and to kill off those that are found to be persistently infected, and in both cases the question of compensating the owners is in point.

The Service measures in operation are :—

1. *Notification.*—This may be regarded as complete.

2. *Milk.*—Condensed milk has been substituted for goats' milk in both military and naval hospitals. This change had been decided on just before the goat-herds' strike in May in the case of the military hospitals, and it dates from the period of that strike in the case of barracks. We had begun the campaign against the use of goats' milk in barracks and hospitals at the end of April.

3. *Goats.*—The entry of goats into barracks has been prohibited, as well as their being kept in the neighbourhood of barracks.

4. *Instructions to Soldiers and Married Families.*—Soldiers and the married soldiers' families have been warned as to the dangers of using goats' milk, and they are being taught that it is very necessary to guard against making use of goats' milk, or of articles made from it, outside their barracks or quarters.

Measures for stamping out the disease resolve themselves into measures for dealing with infected goats, and measures directed to control of the milk supplies. Measures of this kind have already been dealt with in the Reports to the Commission by Horrocks and Kennedy (*vide* Part IV, p. 82).

These observers recommended :—

1. That the perambulation of goats through the streets of the towns in Malta should be strictly forbidden.

2. That all goats showing a persistent blood reaction should be

destroyed, as examinations of milk alone cannot be taken as a basis of action, owing to the excretion of the *Micrococcus melitensis* being intermittent in character.

3. That the milking of goats should be done in their pens or in some central depôt.

4. That the goats should be penned as far as possible from human habitations.

5. That the milk should be transmitted to the towns in sealed cans.

6. That promiscuous micturition should be prohibited, and a penalty imposed on offenders.

The second of these measures implies, of course, the organisation of arrangements for the examination of goats and for the segregation of those found to be infected for further observation. It would be, perhaps, beyond the limits of practicability to undertake the systematic observation of all the goats in Malta. It would mean making from 15,000 to 20,000 milk or serum agglutination tests every few weeks. The practical measure, at all events to begin with, would appear to be the examination of all goats suspected to be infected, and occasional test examinations of herds.

We recommend, in addition, that all goats intended for exportation should be examined before shipment, say a fortnight before and again a day or two before being shipped, and no reacting goat should be allowed to be put on board.

We do not agree that goats should be milked in their pens, but we strongly support the formation of milk depôts in all important centres, which, if not Government institutions, should be under the control and strict supervision of the Public Health Department. We are in complete agreement with the rest of the foregoing recommendations.

The existing sanitary laws would appear to give sufficient powers to the authorities, both in regard to the control of the goats and of the sale of milk to the public, if they are only enforced and carried out both in spirit and in letter.

The Malta Sanitary Ordinance, No. III of 1904, Chapter II, Section V, Articles 79 to 100, already provides:—

1. That all purveyors of milk shall be licensed, and that the licence shall only be granted on condition that the dairy is well built, fitted with impervious floors, well ventilated, and otherwise sanitary (Articles 79 and 80).

2. Dairies are to be kept clean and periodically limewashed (Article 81).

3. Goats and cows are to be notified and inspected (Articles 82 and 83); and cows are to be branded on the horns and hoofs (Article 82).

4. Sickness is to be at once notified and the animal inspected. If the disease from which the animal is suffering be declared infectious,

the person authorised to inspect the animal shall forbid the sale of the milk, and shall apply other preventive measures (Article 84).

5. No milking operations or any handling of milk shall be made by anyone who may be suffering from, or recently convalescent from, any infectious disease, or who lives in the same house with such cases (Article 86). Certain diseases are specified, but Mediterranean Fever is not named among them.

6. Living places are not to be used for storing milk, and cow sheds shall not communicate with the place in which milk is kept or sold, but shall be separated therefrom by an open space (Articles 87 and 88).

7. The cleanliness and method of cleansing of utensils and vessels used for the preservation and sale of milk is also legislated for (Articles 89 and 90).

8. No one shall expose or keep for sale the milk of animals stricken with any disease held to be capable of altering the nature of the milk (Article 91, *b*).

9. It is part of the duty of the Government veterinary surgeon to watch over the hygiene of stalls, and the state of health of animals destined for the production of milk. (Ordinance dealing with the organisation of the Public Health Department, Chapter VIII, Article 40, *e*.)

10. There is a Council of Health which advises the Government on all matters affecting hygiene and the public health. It has on it one naval and two military representatives.

The relative importance of goats and cows, as sources of milk supply in Malta, did not receive due consideration when this Ordinance was framed, as in many of the provisions the word "cow" alone is used, and it is only by implication that they can be held to apply to goats.

Actual observations of the conditions obtaining in the places where goats are penned or housed, which were made in the course of our work, show that the regulations in regard to housing are more honoured in the breach than in the observance. The Ordinance is yet young, and it has to be remembered that the enforcement of the law means very radical alterations in the conditions previously prevailing. It was an attempt to enforce the provision of impervious flooring and limewashing in specific instances that led to the goat-herds' strike. The goat-herds are an uneducated class, and much prejudiced against what they consider unnecessary innovations. It will probably take a long time before these prejudices are overcome, and the only alternative appears to be dairies or depôts belonging to Government, or large owners, and in the latter case under Government control.

To sum up, we recommend as follows :—

A. *Measures relating to Goats.*

1. The perambulation of goats through the streets should be strictly forbidden.
2. The branding of goats on the hoofs should be carried out, as in the case of cows.
3. The goats should be penned or housed as far as possible from human habitations.
4. Examination of goats suspected to be infected.
5. Examination of all goats intended for exportation before shipment.
6. Segregation of reacting goats for observation.
7. Destruction of goats showing persistent infection.
8. Compensation to owners on two scales: (*a*) while their goats are segregated, and (*b*) for goats destroyed.

B. *Measures relating to Milk Supplies.*

1. The establishment of large dairies or depôts under Government control or supervision.
2. The transmission of the milk in sealed cans to proper dairies in the towns.

C. *Other Measures relating to the Civil Population.*

1. More strict notification.
2. Efforts should be made to extend the practice of having blood examinations made in cases of fever.
3. Impress on sanitary inspectors the importance of their milk enquiries.
4. As recommended by Horrocks and Kennedy, educate the people by leaflets telling of the importance of preserving some degree of sanitation in their dwellings, the dangers of infected milk, need for milk sterilisation, etc.
5. Promiscuous micturition in the streets and roads should be prohibited, and a penalty imposed on offenders.
6. Latrine accommodation should be provided for workmen employed in building operations.

D. *Measures specially applicable to the Services.*

1. With regard to the garrison, the isolation of Mediterranean Fever cases should be continued.
2. The entry of goats into barracks or other Government places should be strictly prohibited; and they should not be allowed to be housed, nor should resting-places be permitted to be established in the neighbourhood of such places.

3. Pending the possibility of obtaining *absolutely safe* milk, the use of goats' milk, or its products, should be absolutely forbidden in any hospital, barracks, ship, or other Government establishment. Sterilisation cannot be trusted.

4. The use of condensed or other forms of preserved milk should be continued in hospitals and barracks, including messes and other regimental institutes.

5. Continue the warnings to soldiers and to soldiers' families as to making use of goats' or cows' milk outside barracks or quarters.

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